

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY
SURVEY, E. A. BIRGE, DIRECTOR; COLLEGE OF AGRICULTURE, UNI-
VERSITY OF WISCONSIN, H. L. RUSSELL, DEAN; A. R. WHITSON,
IN CHARGE SOIL SURVEY.

RECONNOISSANCE SOIL SURVEY OF SOUTH PART OF NORTH-CENTRAL WISCONSIN.

BY

W. J. GEIB, IN CHARGE, ARTHUR E. TAYLOR, J. B. R. DICKEY,
AND CARL THOMPSON, OF THE U. S. DEPARTMENT OF AGRI-
CULTURE, AND T. J. DUNNEWALD AND CLINTON B.
POST, OF THE WISCONSIN GEOLOGICAL AND
NATURAL HISTORY SURVEY.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1915.]



WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., January 26, 1917.

SIR: I have the honor to transmit herewith the manuscript report and map covering the reconnoissance soil survey of the south part of north-central Wisconsin area, and to request that they be published as advance sheets of Field Operations of the Bureau of Soils, 1915, as authorized by law.

The selection of this area was made after conference with the State officials cooperating with the bureau in the work of surveying and classifying the soils of Wisconsin.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

CONTENTS.

	Page.
RECONNOISSANCE SOIL SURVEY OF SOUTH PART OF NORTH-CENTRAL WISCONSIN. By W. J. GEIB, IN CHARGE, ARTHUR E. TAYLOR, J. B. R. DICKEY, and CARL THOMPSON, OF THE U. S. DEPARTMENT OF AGRICULTURE, and T. J. DUNNEWALD and CLINTON B. POST, OF THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY.....	5
Description of the area.....	5
Location and area.....	5
Topography and elevation.....	5
Regional drainage.....	7
Settlement and early history.....	7
Population.....	8
Transportation.....	9
Markets.....	10
Climate.....	10
Precipitation.....	10
Growing season.....	11
Temperature.....	13
Agriculture.....	13
History and development.....	13
Principal crops.....	15
Special crops.....	17
Live stock and dairying.....	18
Farm methods.....	20
Area and value of farm land.....	21
Soils.....	22
Origin and relation to geology.....	22
Gloucester series.....	24
Gloucester gravelly sandy loam.....	25
Gloucester gravelly silt loam, shallow phase.....	25
Gloucester sand.....	26
Gloucester fine sand.....	27
Gloucester sandy loam.....	28
Gloucester fine sandy loam, rolling phase.....	29
Gloucester fine sandy loam, shallow phase.....	31
Gloucester loam.....	32
Gloucester silt loam.....	34
Spencer series.....	38
Spencer loam.....	38
Spencer silt loam.....	39
Whitman series.....	44
Whitman fine sand.....	44
Whitman silt loam.....	45
Merrimac series.....	46
Merrimac sandy loam.....	46
Merrimac fine sandy loam.....	47
Merrimac silt loam.....	48

RECONNOISSANCE SOIL SURVEY OF SOUTH PART OF NORTH-CENTRAL WISCONSIN—Continued.

Soils—Continued.

	Page.
Plainfield series.....	49
Plainfield gravelly sand.....	50
Plainfield sand.....	51
Plainfield fine sand.....	52
Vesper series.....	53
Vesper silt loam.....	53
Boone series.....	54
Boone fine sand.....	54
Boone fine sandy loam.....	55
Boone silt loam.....	57
Genesee series.....	58
Genesee sand.....	58
Genesee silt loam.....	59
Miscellaneous material.....	60
Peat.....	60
Rough stony land.....	62
Summary.....	63

ILLUSTRATIONS.

PLATES.

	Page.
PLATE I. Gloucester fine sandy loam, rolling phase, Taylor County.....	32
II. View on Gloucester loam, near Neillsville, Clark County.....	32
III. Fig. 1. Spencer silt loam, showing nearly level surface and well-improved farm. Fig. 2. Spencer silt loam, rolling phase.....	48
IV. Road-cut on the Boone fine sandy loam, poorly drained phase.....	48

FIGURES.

Fig. 1. Sketch map showing location of the South Part of North-Central Wisconsin area.....	5
2. Sketch showing length of growing season in the area surveyed as compared with other parts of Wisconsin.....	12

MAP.

Soil map, South Part of North-Central Wisconsin sheet.

RECONNOISSANCE SOIL SURVEY OF SOUTH PART OF NORTH-CENTRAL WISCONSIN.

By W. J. GEIB, In Charge, ARTHUR E. TAYLOR, J. B. R. DICKEY, and CARL THOMPSON, of the U. S. Department of Agriculture, and T. J. DUNNEWALD and CLINTON B. POST, of the Wisconsin Geological and Natural History Survey.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

LOCATION AND AREA.

The area mapped as the South Part of North-Central Wisconsin is made up of four counties—Taylor, Lincoln, Clark, and Marathon—and comprises an area of about 4,665 square miles, or approximately 2,985,600 acres. Its southern boundary is 132 miles north of the Illinois-Wisconsin line, and its northern boundary 70 miles south of Lake Superior. The area is 84 miles long, from east to west, and 78 miles wide. Wausau, the largest city, is in practically the same latitude as St. Paul, Minn., Salem, Oreg., and Bangor, Me., and in about the same longitude as New Orleans, La., Memphis, Tenn., and Springfield, Ill.

A general report and map of the soils of north-central Wisconsin were published by the Wisconsin Geological and Natural History Survey in 1903. This early report included Wood and Portage Counties, in addition to the area covered by the present survey, and was prepared by Dr. Samuel Weidman in connection with a geological survey of the region. While this early soil survey was of a more general character than the present, both the report and map have been of material assistance in the preparation of the present soil map and report.

TOPOGRAPHY AND ELEVATION.

The most prominent physiographic feature of the area is the terminal moraine which extends across Taylor County from the southwestern corner to the northeastern corner. This moraine crosses

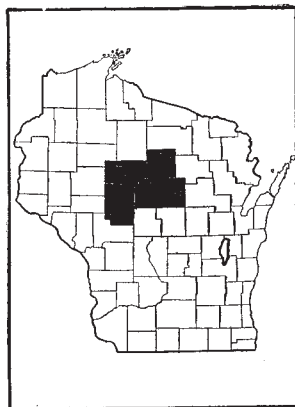


FIG. 1.—Sketch map showing location of the South Part of North-Central Wisconsin area.

Lincoln County, extends southward through Langlade County, east of the survey, and crosses the eastern and southeastern parts of Marathon County. It consists of a series of hills and ridges, with numerous steep slopes, kettle holes, and other depressions. The morainic belt varies in width from a few miles to 8 or 10 miles or more and marks the limits of the advance of the late Wisconsin ice sheet.

Within the region covered by the present survey there are two distinct types of topography. The surface of the area covered by the late Wisconsin ice sheet, occupying most of Taylor and Lincoln Counties and the eastern part of Marathon County, is characteristic of a glaciated region. The surface varies from level to rolling and hilly, and there are a large number of marshes, lakes, and kettle holes, together with extensive areas of ground moraine, outwash plains, and valley filling. Geologically the topography is young, and throughout this region the drainage channels are not well established.

The area south of the terminal moraine may be divided into two sections: (1) That known as the unglaciated region in central Marathon County, and (2) the section to the west, comprising the western part of Marathon County and most of Clark County, which was traversed by early ice sheets. Throughout the unglaciated region, where the soils are largely of residual origin, the surface is mainly broadly rolling, with rounded hilltops and long, rather gentle slopes. Streams have cut deep channels through this region, though there are few steep slopes. In the old glaciated region to the west the surface is very gently undulating to gently rolling. The slopes are long and gentle, and because of the heavy character of the soil the drainage is often deficient. Throughout the unglaciated region and also the region of old glaciation to the west there are few swamps or lakes, and from a geological standpoint the topography is much more mature than in the region covered by the late Wisconsin ice sheet.

A prominent topographic feature in the area surveyed is Rib Hill, about 3 miles southwest of Wausau. This has the distinction of being the highest point in the State, and it approaches the proportions of a mountain more nearly than any other elevation in Wisconsin. Another rather conspicuous feature is the terrace formations along the Wisconsin River and its tributaries. These are most extensively developed south of Wausau, in the vicinity of Schofield. They extend up the valleys of Big Rib, Little Rib, and Eau Claire Rivers, as well as both northward and southward along the Wisconsin River.

Rib Hill has an elevation above sea level of 1,940 feet, while the Black River below Dells Dam, at a point 3 miles north of the south

line of Clark County, has an elevation of 784 feet above sea level. This is about the lowest point in the area, so that there is an extreme range in elevation of about 1,100 feet. The greater part of the area lies between 1,000 and 1,600 feet above sea level.

REGIONAL DRAINAGE.

The portion of Marathon County within and to the east of the terminal moraine is drained through tributaries of the Wolf River into Lake Michigan. The remainder of the region surveyed drains through three separate river systems into the Mississippi. The Wisconsin River, which receives most of the drainage from Lincoln and Marathon Counties, crosses these two counties from north to south and has for its largest tributaries the Tomahawk, Big and Little Rib, Eau Claire, Eau Pleine, Little Eau Pleine, and Plover Rivers. The Black River, which drains most of Taylor and Clark Counties, is considerably smaller than the Wisconsin River. The Eau Claire River, with its tributaries, Jump and Yellow Rivers, and a number of smaller streams, constitutes the third system. It receives the drainage from the extreme western part of Taylor County and from the northwestern part of Clark County.

Branches from the main streams ramify into all parts of the area, and practically all the farms have drainage outlets. There are areas of considerable extent in the region of the old glaciation where the surface is nearly level and where the natural drainage is somewhat deficient, but marshes are of rather limited extent. Throughout the unglaciated part of the region the drainage usually is very good, though there are some low-lying areas that are deficient in drainage. Throughout the morainic belt where the soils are light the drainage is excessive, and the soils are somewhat droughty. Within the area of recent glaciation there are numerous marshes and, in addition, some low, poorly drained tracts.

Along the Wisconsin River the flood plain is from 100 to 200 feet lower than the adjoining upland, and in some places the valley walls are steep. The valley of this stream is a prominent topographic feature. The Black River also has cut a well-marked valley, although terraces are not so extensively developed along this stream as along the Wisconsin River. All the streams of the area are still cutting away their beds, none having reached base level. Practically all the streams are swift flowing, and much water power is available, extensive developments of which have been made at Tomahawk, Merrill, Wausau, Schofield, Mosinee, and several other places within the area.

SETTLEMENT AND EARLY HISTORY.

Permanent settlements in this region were first made about 1840. In 1852-53 original land surveys were made in Ts. 26 to 30 N. and

Rs. 2 to 10 E. In 1861-1865 original surveys were made in Ts. 31 to 44 N. and Rs. 2 to 9 E. Practically all the early transportation was by boat on the Wisconsin River. The territory now included in Marathon and Clark Counties was the first to be settled and developed. In Clark County the Black River was the chief avenue of commerce before the advent of the railroads. The first industry of importance in this region was the cutting of pine timber. That near the watercourses was the first to be removed. In the spring of 1851 one of the first large shipments of lumber was rafted down the Wisconsin and Mississippi Rivers to Galena, Ill.

Settlement by German immigrants began in 1855, and agricultural development may be said to date from about this time, although the area actually placed under cultivation was at first very small. Lumbering continued the most important industry until all the merchantable pine was removed. After the cutting of the pine the maple and birch trees were removed, and it was in the hardwood sections that the first agricultural development took place.

The first railroad to be built into this section was the Wisconsin Central, now a part of the Minneapolis, St. Paul & Sault Ste. Marie Railway system, which was constructed through the area in 1872-73. In 1874 the present Chicago, Milwaukee & St. Paul Railway was built to Wausau; this line was extended to Merrill in 1881. After the completion of these railroads settlement and development were rapid.

POPULATION.

Marathon and Clark Counties constitute the most thickly settled and highly developed part of the survey. Over these two counties the population is quite evenly distributed, with the exception of the southwestern and southern parts of Clark County, which are rather thinly settled, and a few areas in Marathon County from which the timber has not been removed and which are also rather thinly settled. Lincoln and Taylor Counties contain the largest areas of unimproved land in this general region, there still being considerable virgin forest. The southern and southeastern parts of Taylor County and the southern part of Lincoln County, in the vicinity of Merrill, are quite thickly settled, but away from these sections there are large areas of undeveloped land. The census of 1910 reports the population of Marathon County as 55,054, Clark County 30,074, Lincoln County 19,064, and Taylor County 13,641, giving a total for the area surveyed of 117,833. Wausau, which is the largest town in the area and the county seat of Marathon County, has a population of 16,560, according to the 1910 census, and Merrill, which is the next largest town and the county seat of Lincoln County, a popu-

lation of 8,689. The population of Medford, the county seat of Taylor County, is given as 1,846, and that of Neillsville, the county seat of Clark County, as 1,957. Tomahawk, in the northern part of Lincoln County, has a reported population of 2,907. By far the greater part of the population is classed as rural by the census.

A large part of the population is German or of German descent, though probably the greater part is American born. There are a number of settlements made up almost entirely of Poles, Scandinavians, or people of other nationalities, but these represent only a small part of the total population.

TRANSPORTATION.

Nearly all parts of the area surveyed are supplied with railroad facilities. A branch of the Chicago, Milwaukee & St. Paul crosses Marathon and Lincoln Counties, passing through Dancy, Mosinee, Wausau, Merrill, and Tomahawk. A branch of the Chicago & North Western crosses the area east and west, passing through Wausau and Neillsville and intermediate points; another branch enters Taylor County from the west and extends to Hughey. Branches of the Minneapolis, St. Paul & Sault Ste. Marie from Ashland and Superior traverse the area and join at Spencer, a line extending from this point directly to Chicago. The branch extending to Minneapolis and St. Paul also connects with the other lines in the area, and the line extending from the Twin Cities to Sault Ste. Marie crosses the northern part of Lincoln County. The Fairchild & Northeastern is a small road branching off from the Chicago & North Western at Fairchild and extending through Clark County to Owen. Greenwood is situated on this line. The distance from Wausau to Chicago over the Chicago, Milwaukee & St. Paul is 312 miles, and the distance from Spencer to Chicago over the Minneapolis, St. Paul & Sault Ste. Marie 293 miles, to Ashland 146 miles, and to Minneapolis 171 miles.

The wagon roads through the settled sections of the area usually are in fair condition. Many of the main roads have been improved under the new State highway-improvement law; these are crowned with gravel or crushed rock and are in excellent condition. Where the country is nearly level and the drainage somewhat deficient the side roads are sometimes rather poor, and in the spring when the ground is thawing they are in very bad condition. When the surface has completely dried, however, the roads are very good.

The rural school buildings throughout the area average somewhat better than those of the southern part of the State. In some sections several districts have been combined, and the pupils are carried to and from school in public conveyances.

MARKETS.

The towns and lumber camps within the area afford a market for much of the farm produce, but the greater part is shipped to outside points. Among the agricultural products dairy products probably are most important. Butter and cheese are shipped to various parts of the country, largely through Chicago. Hay is shipped to Milwaukee and other points. Excellent markets are within easy access of all farms.

CLIMATE.¹

PRECIPITATION.

The distribution of rainfall over the State of Wisconsin is remarkably uniform, the average yearly precipitation ranging from 28 to 34 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, or the Danube Valley. It equals that of central Oklahoma and Kansas, northern Iowa, Michigan, or northwestern New York. Owing to its northerly location and consequent lower evaporation, the precipitation is probably as effective as that of Arkansas, Illinois, or Virginia.

The local distribution of rainfall varies from year to year with the movement of cyclonic storms. The average rainfall for the entire State during the driest year recorded was 21.4 inches and during the wettest year 37 inches.

Equal in importance to the total amount of rainfall is its seasonal distribution, and in this respect conditions in Wisconsin are very favorable to agriculture. About one-half the rainfall occurs in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. The State receives during this period an average of 21 inches of precipitation, or as much as eastern Texas, Illinois, Ohio, or eastern New York. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is light. December, January, and February each average 1 to 1.5 inches of rain and melted snow. The mean annual snowfall, unmelted, at Neillsville is recorded as 40.7 inches. The light winter precipitation in Wisconsin, occurring mainly in the form of snow, causes practically no erosion or leaching of plant food from the soil. The average precipitation for the State for the winter is 3.9 inches, for the spring 8.3 inches, for the summer 11.4 inches, and for the fall 7.4 inches.

Occasional periods of drought or of unusually heavy rainfall occur, continuing for one week to four weeks or even longer. Observations

¹ This chapter is based upon Bul. No. 223, Univ. of Wis. Agr. Expt. Sta., "The Climate of Wisconsin and its Relation to Agriculture."

made at Madison by the Weather Bureau covering a period of 30 years from 1882 to 1911, inclusive, show an average of three 10-day periods in each growing season in which crops on a moderately heavy soil suffer from lack of moisture. A similar condition prevails in the area surveyed and is even more marked on the light-textured soils.

The table below gives the mean precipitation at three points within the survey. Records for Madison also are given for purposes of comparison with southern Wisconsin.

Mean monthly, seasonal, and annual precipitation.

Month.	Wausau.	Neills- ville.	Medford.	Madison.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
December.....	1.26	1.63	1.29	1.72
January.....	1.16	1.11	.96	1.63
February.....	1.11	1.42	1.09	1.50
Winter.....	3.53	4.16	3.34	4.85
March.....	1.84	2.14	1.45	2.08
April.....	2.58	2.84	2.26	2.54
May.....	4.11	4.24	4.26	3.66
Spring.....	8.53	9.22	7.97	8.28
June.....	4.18	4.91	5.10	4.01
July.....	4.19	3.79	4.09	3.80
August.....	3.58	3.28	3.52	3.15
Summer.....	11.95	11.98	12.71	10.96
September.....	3.70	3.77	4.05	3.08
October.....	3.02	2.92	3.41	2.32
November.....	1.70	1.74	1.57	1.76
Fall.....	8.42	8.43	9.03	7.16
Year.....	32.43	33.97	33.05	31.25

GROWING SEASON.

The northern part of the area occupies the southern slope of the Northern Highland and the southern part the northern extremity of the Southern Highland. These highlands constitute two of the eight climatic provinces of Wisconsin. In the northern part of the survey the growing season is about 110 days, while in the southern part it is about 130 days. Clark and Marathon Counties have a growing season of nearly the same length as that of Juneau, northern St. Croix, northern Trempealeau, and northern Sauk Counties.

The normal growing season at Wausau is 115 days, at Neillsville 120 days, and at Medford 101 days; the average growing season at Madison is 179 days. In the extreme northern part of the area surveyed summer frosts may occur, but these rarely are heavy enough to injure growing crops. As the timber is cleared away, the land more thoroughly drained, and more of the area put under cultivation, the growing season lengthens.

TEMPERATURE.

The table below gives the mean monthly, seasonal, and annual temperature as recorded at three stations within the area. Records for Madison also are given, so that the temperatures may be compared with those prevailing in the southern part of the State.

Mean monthly, seasonal, and annual temperature.

Month.	Wausau.	Neillsville.	Medford.	Madison.
	° F.	° F.	° F.	° F.
December.....	18.3	19.1	17.9	22.8
January.....	14.8	13.1	12.9	16.9
February.....	14.9	13.8	13.6	18.7
Winter.....	16.0	15.3	14.8	19.5
March.....	27.6	27.8	26.2	30.4
April.....	43.0	44.2	42.1	45.6
May.....	55.4	55.5	53.9	57.6
Spring.....	42.0	42.5	40.7	44.5
June.....	64.6	65.9	65.1	67.3
July.....	68.3	69.8	68.8	72.0
August.....	66.5	67.1	67.1	69.7
Summer.....	66.5	67.6	67.1	69.7
September.....	59.2	59.4	59.7	62.3
October.....	46.9	46.9	46.0	50.0
November.....	32.3	31.3	30.2	35.1
Fall.....	46.1	42.5	45.3	49.1
Year.....	42.6	42.8	42.0	45.7

AGRICULTURE.

HISTORY AND DEVELOPMENT.

The most reliable records available indicate that the first farming operations in the area surveyed were undertaken by a settler in what is now Berlin Town, Marathon County, in 1856. At that time the total population of Marathon County was about 500, but these early

settlers were engaged in other industries. The following year a number of families, some coming from Germany, settled in the region for the purpose of farming. Farming operations were begun about the same time in Clark County, but in neither of these counties was agriculture important prior to the close of the Civil War.

It was thought at first that the winters were too long and the summers too short for farming, but it was soon demonstrated that good crops could be grown in almost all parts of the area. Many of the early farmers were obliged to cut the timber and burn the logs, as the hardwood was of little value, only the pine being handled by the mills. It was a common practice in the early days, and is at the present time in the less developed sections, for farmers to work in the logging camps and mills during the winter months and to cultivate their fields and clear additional land in the summer. The farming methods originally followed were crude, but the virgin soil was very productive, and heavy yields were often obtained with little attention given to seed selection or cultivation.

Between 1870 and 1880 a large number of new farms were taken up in Marathon and Clark Counties; and, according to the census of 1880, there were 1,705 farms in Marathon County and 1,556 in Clark in that year. At this time comparatively few farms were operated in Taylor and Lincoln Counties. After 1880 agriculture developed rapidly, especially in Clark and Marathon Counties, and at the present time large sections of these two counties are as thickly settled and as highly developed as many of the leading farming districts of southern Wisconsin. In Taylor and Lincoln Counties, however, there are large tracts of cut-over land in which no settlements have been made, and also extensive tracts of virgin forest of hardwood and hemlock.

The crops grown most extensively by the early settlers were hay, oats, and potatoes and other root crops. Oats and hay early became important sources of income, as the lumbermen required large quantities of feed for their stock. Wheat was grown to some extent in the older communities for a number of years, but the small grains have never attained as much importance here as in older sections of the State, chiefly because the oldest agricultural communities here had just become well established when grain growing elsewhere was at its height. With the decline in grain production more general farming was practiced, and dairying came to occupy an important place. Hay was often cut 5 to 10 years on the same field, and when the yields were no longer profitable the field was plowed for other crops. Little thought was given to crop rotation in the early days.

The following table, compiled from the census reports, shows the population, the number of farms, land in farms, and percentage of improved land in farms, by decades, since 1880:

Population and status of farm land, 1880 to 1910.

	Year.	Marathon County.	Clark County.	Taylor County.	Lincoln County.
Per cent of land area in farms.....	1880				
	1890	27.76	23.82	10.34	11.00
	1900	44.50	41.80	16.30	17.10
	1910	53.60	52.80	21.50	21.60
Total number of farms.....	1880	1,705	1,566	266	153
	1890	2,789	2,086	752	504
	1900	4,276	3,456	1,168	924
	1910	5,080	4,196	1,582	1,119
Total population.....	1880	17,121	10,715	2,311	2,011
	1890	30,369	17,708	6,731	11,008
	1900	43,256	25,848	11,262	16,269
	1910	55,054	33,074	13,641	19,064
Average value of farm land per acre.....	1880				
	1890				
	1900	\$14.29	\$19.57	\$10.88	\$10.57
	1910	29.35	34.68	23.31	21.67

The growth of the dairy industry in Clark and Marathon Counties has been very rapid, particularly in the last 20 years. In Clark County alone the value of the dairy products, excluding those used in the home, increased from \$188,979 in 1900 to \$1,171,341 in 1910. At present it is estimated that the yearly value of dairy products is close to \$1,750,000. The value of dairy products in 1900 and in 1910 increased from \$136,058 to \$883,816 in Marathon County, from \$29,411 to \$138,753 in Lincoln County, and from \$26,598 to \$240,383 in Taylor County. This rapid growth in dairying has been accompanied by an increase in the acreage of hay, corn, and small grain, and also by a very substantial increase in land values.

At the present time the prevailing type of agriculture consists of general farming in conjunction with dairying, with hay and oats as the most important crops. This type of farming is followed in practically all the cleared sections of the area surveyed, and the older the community the higher its development. In the new communities potatoes constitute the leading money crop.

PRINCIPAL CROPS.

The crops most extensively grown in the area, named in order of acreage, are hay, oats, barley, corn, potatoes, rye, and wheat. Hay occupies more than twice the acreage of any other crop. Over 75 per cent of the hay produced consists of mixed clover and timothy, the remainder being made up of these crops grown alone, marsh hay, millet, and grains cut green, with a very small proportion of alfalfa and pea vine. The average yield of hay of all kinds is about 1½

tons per acre, but clover and timothy frequently yield 2 to 3 tons per acre on the best soils. The Spencer silt loam is the best hay and grass soil in the area. The Gloucester silt loam also gives good yields of hay. The light sandy types are not well adapted to hay crops, and yields are light. Some clover seed is grown, mainly medium red and alsike. The soils in this region show varying degrees of acidity, and alfalfa can not be grown successfully without liming the soil. Inoculation also is necessary.

Oats occupy a larger acreage than all other grains combined. The average yield for the entire area in 1909 was approximately 30 bushels per acre. Yields on the light sandy soils are small, but on the silt loams and fine sandy loam types yields of 50 bushels per acre are common, and yields of 70 to 80 bushels per acre frequently are reported. Much of the oat crop is fed to stock on the farms, but on most farms oats are also grown for sale.

Barley is the second grain crop in acreage. The average yield in 1909 was about 25 bushels per acre. Most of the crop is grown on silt loam types, and some on fine sandy loam soil. On both of these it does very well, but on lighter soils the yields are low. From the best fields yields of 35 to 50 bushels per acre are common.

Corn is the third grain crop in the area in point of acreage. The average yield in 1909 was slightly over 31 bushels per acre. Yields of 40 to 50 bushels per acre are not uncommon, and higher yields are sometimes reported. In addition considerable corn is grown for ensilage, particularly in Clark and Marathon Counties; the acreage grown for ensilage probably is equal to that allowed to mature. With the development of dairying the number of silos greatly increases and the acreage devoted to corn is extended. Golden Glow, Silver King, and Wisconsin No. 8 are dent varieties that are grown successfully, in addition to the native yellow dent corn of mixed breeding. Some flint corn also is grown, but the acreage does not seem to be increasing. Throughout the southern part of the area on well-drained land the dent varieties can be depended upon to mature four out of five years. Corn is grown on nearly all types of soil, but does best on well-drained silt loams, loams, and fine sandy loams. In this region the loams and heavy fine sandy loams are best suited to corn, as they warm up earlier than the heavier soils. Level areas of the Spencer silt loam and Merrimac silt loam are cold and late.

Rye is grown in all four counties, but only to a small extent. Yields average about 18 bushels per acre. The crop is grown mainly on the sandy soils, and does better on such types than the other small grains.

Wheat can be grown successfully, but has never occupied an extensive acreage in this region. In 1909 the average yield in Marathon County was about 15 bushels per acre.

Over some parts of the area potatoes may be classed with the general farm crops, although they usually are considered a special crop. Potato growing on a commercial scale has not been extensively developed in the area, except at a few points. The sandy types in the valley of the Wisconsin River and its tributaries produce most of the potatoes; on the heavy soils, such as the Spencer silt loam, they are grown chiefly for home use. Where the drainage is good, however, good yields can be obtained on the heaviest types of soil in the area. In 1909 the average yield in Marathon County was about 95 bushels per acre, and in Clark County about 110 bushels, while in Taylor and Lincoln Counties it was between 135 and 140 bushels per acre. The varieties grown most extensively are the Early Ohio, Triumph, Hebron, Early Rose, Rural New Yorker, and Burbank. Efforts are being made to encourage the growing of fewer varieties and purer strains in order to secure a greater uniformity in both market and seed stock.

Peas are grown chiefly for seed, and occupy only a small acreage. The crop does well on many of the soils and could profitably be grown to a greater extent. Yields usually range from 15 to 20 bushels per acre. Buckwheat is grown with success, but the acreage is not large. Yields usually range from 15 to 18 bushels per acre. While beans could be grown successfully in many portions of the area, the acreage devoted to this crop also is small. It is grown chiefly on the sandy soils.

The following table, compiled from the census, gives the acreage and production in 1909 of various general farm crops in each of the four counties surveyed:

Statistics of agricultural production by counties, 1909.

Crop.	Acreage and production of principal crops in—							
	Marathon County.		Clark County.		Taylor County.		Lincoln County.	
	<i>Acres.</i>	<i>Tons.</i>	<i>Acres.</i>	<i>Tons.</i>	<i>Acres.</i>	<i>Tons.</i>	<i>Acres.</i>	<i>Tons.</i>
Hay ¹	69,596	102,477	60,239	104,261	18,239	27,951	13,678	17,909
		<i>Bushels.</i>		<i>Bushels.</i>		<i>Bushels.</i>		<i>Bushels.</i>
Corn.....	3,742	131,419	8,833	264,560	214	7,587	275	7,944
Oats.....	38,085	1,058,750	24,455	809,770	3,507	112,960	5,807	168,328
Barley.....	12,244	312,449	9,063	234,002	1,510	40,620	1,178	27,294
Potatoes.....	6,856	649,764	2,992	336,540	1,193	170,356	1,477	199,890
Rye.....	3,985	62,194	2,972	59,378	523	10,955	297	5,282
Peas.....	1,699	26,795	376	7,729	196	4,479	257	4,105
Wheat.....	1,878	29,493	1,116	23,625	70	1,536	107	1,952

¹ Includes only tame grasses and forage.

SPECIAL CROPS.

There are a few special crops grown within the area, but no one line of intensive agriculture has become highly developed in this part

of Wisconsin. Sugar beets can be grown successfully, but the present acreage is very small. The Gloucester silt loam and well-drained areas of Spencer silt loam and Merrimac silt loam are well adapted to this crop.

Ginseng is grown in a number of places, but the total acreage is small. One of the gardens at Wausau is said to be the largest in the United States. All the ginseng gardens are artificially shaded, and great care and patience are necessary in growing this crop. The dry roots constitute the main product, but dry seed and germinated seed are also sold. The dry roots bring from \$4 to \$7 a pound at local markets. It requires 18 months for the seed to germinate, and it is about 5 years from the time the seed is planted until the roots are large enough to market.

Apples are the most important tree fruit, but they are grown only in small home orchards. In 1909 Clark and Marathon Counties produced 33,824 bushels of apples. Most of the orchards are on the Gloucester silt loam and well-drained areas of the Spencer silt loam, but on a number of farms on these types there are no apple trees.

Strawberries are grown in all parts of the area for home use. They are produced commercially in a small way in some places. The 1910 census reports a production of 30,767 quarts from 18 acres in Clark County, and 14,740 quarts from 9 acres in Marathon County. The fine sandy loam, loam, and well-drained areas of silt loam soils produce berries of good quality.

Raspberries and blackberries grow wild throughout the area, and can be grown commercially with profit, but their production receives little attention. Blueberries also grow wild in some parts of the area, especially on the sandy land in Lincoln County, but no effort is made to cultivate this crop.

LIVE STOCK AND DAIRYING.

The raising of beef cattle is not important at present in this part of Wisconsin, although on many farms some stock is fattened for market. Some of the lumbering companies, as well as individuals owning large tracts of cut-over land, buy up young cattle in the spring, graze them through the summer, and sell them in the fall, either as feeders or as grass-finished cattle. Good pasturage is available throughout the region, especially on the heavier types of soil, and in addition to the profits derived from fattening the cattle their grazing assists in the clearing of the new land. Beef cattle can be kept through the winter, and can be fattened profitably in all the counties of the survey.

Horses are not extensively raised for market, but many farmers raise their own work stock. Heavy horses bring high prices at the logging camps.

In the older parts of the survey hogs are raised, chiefly in conjunction with dairying, but the number is not so great as in sections of the State where corn is more extensively grown. Poland China, Berkshire, and Duroc Jersey are the most popular breeds.

Sheep are raised in smaller numbers than hogs. The flocks might be increased in size to advantage, especially in the well-drained sections, since the animals can easily be carried over the winter and are useful in the clearing of land.

Some poultry is kept on practically all the farms, and the sale of poultry products is a source of considerable income. A few farmers keep bees, and some sell small quantities of honey.

The following table, compiled from the 1910 census, gives a fair idea of the distribution and value of live stock, poultry, and bees:

Number and value of live stock, 1910, by counties.

Stock.	Marathon County.		Clark County.		Taylor County.		Lincoln County.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
		<i>Dollars.</i>		<i>Dollars.</i>		<i>Dollars.</i>		<i>Dollars.</i>
Cattle.....	59,089	1,180,617	58,481	1,365,408	13,630	291,367	9,112	173,841
Horses.....	11,866	1,337,972	11,071	1,160,380	2,803	320,291	2,398	279,064
Hogs.....	18,079	115,347	16,611	128,181	2,706	22,806	3,478	23,938
Sheep.....	24,232	64,012	12,400	50,918	1,730	4,775	3,882	10,789
Fowls.....	149,799	57,211	128,474	52,881	34,027	14,655	31,562	12,361
Colonies of bees.....	2,066	9,046	2,166	7,845	329	1,534	538	2,173

Dairying is the most important branch of agriculture at the present time, and the one that gives the greatest promise of being extended as the undeveloped sections are settled. Animals of Holstein breeding are more numerous than those of other breeds. While the majority are grades, the number of purebred cows is rapidly increasing. Purebred sires are commonly used, and the stock is being steadily improved. One reason for the large number of Holstein cattle is that much of the dairy products is marketed in the form of cheese, and the Holstein produces a large quantity of milk. In addition, where it is desired to turn off some of the stock as veal or as beef the Holstein brings larger returns than other dairy breeds. In 1909 the total value of dairy products for the area surveyed amounted to \$2,434,293. At present the annual output doubtless exceeds \$3,000,000. Most of the dairy output is sold as butter and cheese. The number of cheese factories in this region is increasing, while the creameries are decreasing, especially in the older settled regions. As the country becomes more thickly settled dairying is being extended farther northward, and as rapidly as the land is

cleared dairying is established as the most important permanent industry. Silos are in common use, and the number is rapidly increasing.

The following table, compiled from the 1910 census and from the Wisconsin Dairy Statistics for 1913, gives the number of dairy cows in each county and the number and distribution of cheese factories and creameries:

Status of dairy industry, 1913.

	Marathon County.	Clark County.	Taylor County.	Lincoln County.
Dairy cows, 1909.....	30,430	32,300	7,745	4,642
Milk produced, 1909 (gallons).....	7,950,379	9,960,135	1,363,665	964,843
Creameries:				
1910.....	29	33	11	4
1913.....	17	24	11	5
Cheese factories:				
1910.....	61	50	5	13
1913.....	84	71	5	13
Value of dairy products, excluding home use of milk and cream, 1909.....	\$883,816	\$1,171,341	\$240,383	\$138,753

FARM METHODS.

The adaptation of soils to crops is not as well understood in this region as in older sections of the State. It is generally recognized, however, that certain soils favor certain crops or classes of crops, e. g., that rye will do better on sandy soils than any other small grain. The silt loam soils are better suited to dairying than the sandy lands, as the heavy types are much better adapted to grass and clover, as well as to corn, than the light soils. Potatoes, beans, and buckwheat do well on the sandy types.

Various crop rotations are practiced, but little careful study has been given to the selection of rotations best adapted to the individual types of soil. In many instances fields have been allowed to remain in grass, which is cut for hay, for 5 to 8 years. In other cases small grains have been grown for years in the same field without the introduction of legumes or intertilled crops. In the southern part of the area on the silt loam soils, where considerable corn is grown, a rotation quite commonly followed consists of corn 1 year, followed by oats or barley seeded to timothy and clover. Hay is cut for 1 or 2 years, and the field then pastured for a year or two, after which it is again plowed for corn. On the sandy soils a common rotation consists of rye 1 year, followed by clover, and this crop by potatoes, corn, or beans. Buckwheat may then be grown 1 year.

Barnyard manure is the only fertilizer extensively used, but the supply is never sufficient to treat the cultivated fields more frequently

than once in 6 or 8 years. Large quantities of manure may be obtained from the logging camps, but this is often so full of weed seeds that many farmers hesitate to apply it to their fields. Green manuring is not practiced to any extent, but a few farmers frequently plow under a crop of clover or rye.

The most important weed pests in the area are Canada thistle and quack grass. The use of imported feed in the lumber camps is held largely responsible for the introduction of these weeds. In a number of places they are so abundant as materially to reduce yields in the fields they infest. Wild mustard is abundant in places.

In the older and more thickly settled parts of the area surveyed the farms are, as a rule, well improved. Stone-basement barns are common, the houses are well built, and the farm buildings usually are kept painted and in good repair. Even in the newly opened sections there are many substantial farm buildings. In general, as any part of the region is developed, the temporary home of the settler soon gives way to a good house and outbuildings.

The labor problem is not nearly so serious in this region as in older sections of the State. Many of the men employed in the lumber camps during the winter engage in farming work during the summer. On many of the farms the family is sufficiently large to perform all the work without extra help. Women work in the fields to a considerable extent, especially in the sections settled by foreigners. Extra labor is often needed only at times of haying and harvesting.

In opening up new farms clearing of the land is often difficult. In some sections stones are plentiful, and their removal is sometimes almost as expensive as clearing the land of timber. Usually a site is selected for the location of the farm buildings, and the clearing proceeds from this center. All brush, logs, and stumps may be removed from a small tract for cultivated crops, and a larger area cleared of brush and logs sufficiently to be seeded and pastured. The stumps can then be gradually removed; cultivated crops frequently are grown between them. After a few years the hardwood stumps decay, and can readily be pulled or burned out. Stumps are removed by the use of stumping machines, by blasting with dynamite, and by burning. In many places fires have run through the cut-over country and cleared away most of the underbrush and old logs, so that the cost of preparing the land for the plow is greatly reduced.

AREA AND VALUE OF FARM LAND.

According to the census, 53.6 per cent of the land area of Marathon County was in farms in 1910, of Clark County 52.8 per cent, Taylor County 21.5 per cent, and Lincoln County 21.6 per cent. See table,

page 15. Of the total farm-land area in Marathon County 34.6 per cent was improved, in Clark County 36.9 per cent, in Taylor County 24.8 per cent, and in Lincoln County 26.8 per cent. The average size of farms, as reported, ranges from 86 acres in Taylor County to 112 acres in Lincoln County. In Clark County it is given as 98 acres and in Marathon County as 105 acres. About 95 per cent of all farms in the area are worked by the owners.

The average assessed value of farm land is reported by the census of 1910 as \$21.67 an acre in Lincoln County, \$23.31 an acre in Taylor County, \$29.35 in Marathon County, and \$34.68 in Clark County. The increase in value from 1900 to 1910 was approximately 100 per cent. The selling price of both improved and unimproved land is variable, depending upon the character of the soil, topography, location, improvements, and merchantable timber. Some land of the lightest sandy soils can be bought for \$5 an acre. The best grade of cut-over land frequently brings \$20 to \$25 an acre. The acreage value of most of the wild land without timber ranges from about \$5 to \$25. Hardwood-timber land has a selling value of \$20 to \$50 an acre, depending upon its location, the condition of the timber, and the ease with which it can be removed. In the regions where farming is well developed, as in most sections of Clark County and much of Marathon County, land values are much higher; a number of well-located and well-kept farms have sold for \$100 or more an acre. Probably the majority of the farms in the best developed farming communities would have a selling value of between \$60 and \$100 an acre.

SOILS.

ORIGIN AND RELATION TO GEOLOGY.

The region covered by the present survey is within the Glacial and Loessial soil province. Most of this region, in common with all of northern and eastern Wisconsin, owes the general character of its surface to glacial action. There were two distinct periods of glaciation. The older drift,¹ which probably was deposited by three separate ice sheets, is confined largely to Clark and Marathon Counties. The oldest part of this drift, which may be spoken of as the first drift sheet, is confined largely to southern and southwestern Clark County and a part of southwestern Marathon County. The second drift sheet occurs in central and northeastern Clark County and southwestern Marathon County. The towns of Neillsville, Spencer, Unity, Greenwood, and Loyal are situated in this section. The third drift is found largely in the northern part of Clark County, southeastern Taylor, northern Marathon, and the southern part of Lincoln

¹ See Bul. XVI, Wis. Geol. Survey, on "Geology of North-Central Wisconsin," by Weidman.

County. The boundaries between the various drift sheets usually are rather indistinct. The most pronounced moraine in the old glacial region is known as the Marshfield Moraine and marks the southern limit of the second drift sheet. There is a very conspicuous section of this moraine southwest of Marshfield, Wood County. One of the most important characteristics of areas of this old-drift formation is the compact character of the subsoil. Because of its peculiar texture and structure it is very impervious to the movement of water, and largely because of this the oxidation of the material has not been uniform. Practically all the subsoil material is mottled. The mottling is variable and usually is very marked; it is one of the distinguishing features of this class of material.

In the central part of Marathon County there is a considerable area which is usually spoken of as an unglaciated region and in which the soils are largely of residual origin. Over this area, however, it is not uncommon to find a few glacial boulders, and there is other evidence that this region was influenced to some, though a very slight, extent by glacial action.

The material deposited by the late Wisconsin ice sheet occupies the greater part of Taylor and Lincoln Counties and the eastern and southeastern sections of Marathon County. For the most part the topography of this region is gently rolling to rolling and hilly, and much more irregular than in the region of the older glacial drift. The soils are of much more variable character than is the case in the older drift regions and stones and boulders are much more plentiful.

In general the soils of the region surveyed are derived from glacial drift, from the underlying rocks, or from a blanket of loesslike material that covers a part of the area. Any one soil may have been derived from one or more of these sources.

The glacial drift has been derived largely from the underlying geological formations, of which there are several within the area. Throughout Lincoln and Taylor Counties, most of Marathon County, and along the northern and eastern boundaries of Clark County crystalline rocks make up the underlying formation. These consist largely of granite, with gneiss and schist, slate, rhyolite, diorite, gabbro, quartz-syenite, and nepheline-syenite occurring as the surface rock over rather limited areas. On Rib Hill and on Mosinee Hill quartzite is the surface rock. Conglomerate and quartzite occur as the surface rock in a few places in Marathon County. While all these rocks have contributed to the formation of the soils, the granitic rocks have played by far the most important part in providing the soil-forming material in both the glaciated and unglaciated regions.

Throughout the greater part of Clark County and over isolated areas in Marathon and Taylor Counties Potsdam sandstone is the surface rock. Through most of Clark County this formation has

been overridden by early glacial débris from the north, and has not contributed very extensively to soil-forming material. In the western and southern parts of Clark County, however, it has been the chief source of material. Associated with the Potsdam sandstone is a shaly phase which upon weathering gives rise to a clay or clay loam, but the greater part of the Potsdam sandstone on weathering gives rise to a sandy soil.

Over a large part of the area there appears to have been deposited a loesslike layer, and many of the heavy soils have been derived, at least in part, from this material. This material usually is sufficiently deep largely to obliterate the variations of the underlying material, in so far as these variations affect the character of the surface soil.

The original soil-forming materials have been modified to a greater or less extent by the action of water, by freezing and thawing, by wind action, and by the growth and decay of vegetation, so that there is a marked variation in the texture, structure, color, and organic-matter content of the surface material. The soils in the present survey are grouped in 8 soil series, comprising 24 soil types, exclusive of Peat and Rough stony land. The following table gives the name and the actual and relative extent of each soil type mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Spencer silt loam.....	556,928	44.8	Genesee silt loam.....	35,008	1.2
Rolling phase.....	779,968		Plainfield gravelly sand.....	30,208	1.0
Gloucester silt loam.....	169,856	14.3	Gloucester gravelly sandy loam...	22,656	.7
Shallow phase.....	188,160		Plainfield fine sand.....	22,464	.7
Rolling phase.....	68,992	8.8	Spencer loam.....	20,416	.7
Gloucester fine sandy loam, rolling phase.....	264,512		Whitman fine sand.....	18,944	.6
Peat.....	142,848	5.4	Merrimac fine sandy loam.....	18,880	.6
Shallow phase.....	17,216		Gloucester sandy loam.....	5,824	.6
Boone fine sandy loam.....	71,040	4.7	Shallow phase.....	12,800	
Poorly drained phase.....	68,544		Vesper silt loam.....	14,236	.5
Whitman silt loam.....	96,256	3.2	Merrimac sandy loam.....	10,752	.4
Gloucester loam.....	76,608	2.6	Genesee sand.....	6,208	.2
Gloucester fine sandy loam, shallow phase.....	70,656	2.4	Gloucester gravelly silt loam, shallow phase.....	5,632	.2
Gloucester fine sand.....	54,080	1.8	Boone silt loam.....	4,864	.2
Boone fine sand.....	46,208	1.5	Rough stony land.....	2,240	.1
Plainfield sand.....	44,928	1.5	Gloucester sand.....	1,408	.1
Merrimac silt loam.....	36,160	1.2	Total.....	2,985,600

GLOUCESTER SERIES.

The Gloucester series includes the light-brown or grayish-brown soils in the upland glaciated region, where the glacial débris of which they are composed has been derived largely from the underlying

crystalline rocks. In the lighter textured types it is probable that some of the sandy material was carried by the ice sheet from sandstone formations to the north and mixed with the débris from the crystalline rocks. The soils of this series show varying degrees of acidity.

GLOUCESTER GRAVELLY SANDY LOAM.

The surface soil of the Gloucester gravelly sandy loam consists of a gray or light-brown gravelly sandy loam or somewhat loamy fine sand, which grades at about 3 inches into a reddish, brownish-red, or rusty-colored sand or fine sand, having a loose, open structure. This passes at about 18 inches into a yellow or yellowish-red sand of about the same texture, which extends to a depth far below the reach of the 3-foot auger. Gravel, varying in size from that of a pea to that of an apple, is found throughout the soil section. Boulders frequently occur on the surface.

This type is confined to the northeastern part of Lincoln County in the vicinity of Long, Pine, and Beaver Lakes.

The topography of this soil is decidedly broken. Hummocks, kettle basins, kames, eskers, and sloughs are numerous. There are many small lakes, and small tamarack and cedar swamps. Because of the uneven surface and the open character of the material the drainage is excessive and the type is droughty.

The present growth is largely hemlock, with some birch. Originally there was considerable pine. This type has not been improved, and because of its rough surface and droughty nature it has a rather low agricultural value. To produce profitable crops careful management is required. The improvement of this class of land probably is not to be encouraged under present conditions, with so much land of better quality readily available.

GLOUCESTER GRAVELLY SILT LOAM, SHALLOW PHASE.

The surface soil of the Gloucester gravelly silt loam, shallow phase, to an average depth of about 10 inches, consists of a brown or dark-brown silt loam. In its native state it contains a moderate percentage of organic matter in the surface 2 or 3 inches, which in cultivated fields is more or less thoroughly mixed through the plow section. The subsoil is a yellowish-brown or light-brown gravelly silt loam, the gravel consisting of angular fragments of granitic rock. At depths of 18 to 30 inches there is usually encountered a gravel bed consisting of a mass of angular rock fragments varying in size from that of a pea to that of a hickory nut. The underlying granitic rock usually is reached at depths of 3 to 6 feet, but on some of the hills and sharp ridges the rock outcrops or lies within 1 or 2 feet of the surface.

This soil is quite variable, the covering of silt over the gravel bed ranging in thickness from a few inches to 2 or 2½ feet. In a number of places the gravel is turned up by the plow and is a conspicuous feature in cultivated fields. As a whole the silt covering is sufficiently shallow to make the soil quite different from the Gloucester silt loam, shallow phase.

The surface of this land is rolling and frequently the soil occupies a series of rather sharp ridges. The natural drainage is always adequate and often excessive, the subsoil being quite loose and open because of the high content of angular gravel.

The Gloucester gravelly silt loam, shallow phase, is not extensive. It occurs mainly from 3 to 9 miles southeast and south of Marathon, in Marathon County.

The original forest growth consisted chiefly of maple, with some birch, considerable hemlock, and a scattering of pine.

A small part of the phase has been placed under cultivation, and in most cases satisfactory crops are grown. Where the silt layer is shallow the land is somewhat droughty. The more rolling areas are not well suited to cultivated crops but can be used for grazing. All the general farm crops common to this region can be grown successfully where the topography is favorable.

In the improvement of this soil the supply of organic matter should be increased. Where alfalfa is to be grown it is necessary to apply lime. After the soil has been cultivated for a number of years it is probable that liming will be necessary also for the successful growing of clover. The application of lime has a beneficial effect on most of the farm crops grown.

GLOUCESTER SAND.

The Gloucester sand consists of a brown or grayish-brown medium to fine sand, passing at a depth of 3 to 4 inches into reddish-yellow or rusty-colored sand. Below about 2 feet the material consists of yellow sand. This loose, open material extends to great depths.

This soil has a very small total area, and is confined to the north-eastern part of Lincoln County. It adjoins larger areas in Oneida County to the north. The surface is undulating to gently rolling, and the natural drainage is excessive. The original timber growth consisted chiefly of pine, with some hemlock and a few hardwood trees. All the best timber has been removed.

This type now exists as unimproved cut-over land. It has a rather low agricultural value, and to produce profitable crops requires careful management. So long as there are large tracts of better land it is doubtful whether the improvement of this land would prove profitable.

GLOUCESTER FINE SAND.

The surface soil of the Gloucester fine sand, to a depth of about 6 inches, consists of a brown or grayish-brown fine sand. This grades into reddish-brown or rusty-brown fine sand, changing at 12 to 18 inches to a yellow fine sand, which extends to depths much greater than 3 feet. There is present in both surface soil and subsoil sufficient clay to give the material a slightly loamy feel. Small quantities of gravel in many places are scattered through the soil section.

The type is subject to some variation, and includes small patches of fine sandy loam, sandy loam, and gravelly sand, some of which could be mapped separately in a more detailed survey. Stones and boulders frequently occur.

The Gloucester fine sand occurs mainly in the northern part of Lincoln County, along both sides of the Tomahawk River, north, east, and west of Tomahawk. Smaller areas occur in the southeastern part of Marathon County. This type for the most part occupies moraines in which kettle basins, kames, and sharp ridges are quite common, and the surface is in general rolling, broken, and hilly. The type includes many small marshes. An exception to this topography is found northeast and northwest of Tomahawk, where the surface is nearly level and the type resembles the Merri-mac fine sand, but there are a number of bowlders on the surface in places. Because of the surface features and the structure of the material this type is thoroughly drained, and is often droughty.

The original timber growth was largely pine, though in places it included hemlock and some hardwood. The present growth consists largely of birch, poplar brush, and sweet fern.

A small part of this type is under cultivation. Its producing power is somewhat higher than that of the Gloucester gravelly sandy loam and sand types, but lower than that of the fine sandy loam. Where not too rough and broken it can be farmed profitably, but it requires careful management. The crops grown consist chiefly of small grains, potatoes, hay, and some corn. Fair yields usually are obtained. Some difficulty is experienced in getting clover started, as the soil is acid.

In the improvement of this soil the supply of organic matter should be increased. Where clover can not be established without applying lime such legumes as soy beans or serratella may be grown. The use of commercial fertilizers containing potash and phosphorus may be found profitable in some cases. A rotation consisting of a small grain, followed by clover, and this by potatoes usually gives good results on this kind of land.

GLOUCESTER SANDY LOAM.

The surface soil of the Gloucester sandy loam, to an average depth of about 10 inches, consists of a brown or grayish-brown sandy loam, carrying a small percentage of organic matter. The subsoil is a yellowish-brown or rust-colored sandy loam, which contains considerable fine sand. With increase in depth the soil becomes more sandy, and the deep subsoil usually consists of a yellow or slightly yellowish red sand. Small quantities of gravel are scattered through the soil section, and some appears on the surface in places. The type is quite similar to the Gloucester gravelly sandy loam type, but contains somewhat more fine material and less gravel. It is subject to some variation, but none of the variations are of sufficient extent to be separated satisfactorily on the soil map.

The Gloucester sandy loam is confined to the northeastern part of Lincoln County and to the southeastern and northern parts of Marathon County. The most extensive area occurs in the vicinity of Granite Heights.

The surface is rolling to hilly. Kettle basins, kames, and small marshy tracts are quite common. There are a few level and undulating tracts, but these are small. Because of the surface relief and the open nature of the subsoil the natural drainage is thorough, and usually excessive.

The original forest growth consisted chiefly of pine, with considerable hemlock and some hardwood, largely maple and birch. All the pine has been cut, but some hemlock and hardwood trees remain.

Only a very small part of this type has been placed under cultivation. Because of its rather rough character and somewhat droughty condition its agricultural value is rather low. While it can be farmed successfully, it requires careful management for profitable yields. So long as extensive areas of much better land are available, it is not considered advisable to improve this class of land.

Gloucester sandy loam, shallow phase.—The surface soil of the Gloucester sandy loam, shallow phase, to an average depth of about 10 inches, consists of a brown or grayish-brown sandy loam of medium texture. Below this the material is a yellowish, or sometimes reddish-brown, sandy loam or sand, carrying a high percentage of angular gravel. At a depth of 2 or 3 feet a bed of angular gravel, consisting entirely of disintegrated crystalline rock, usually is encountered. Sometimes the underlying crystalline rock (usually granite) lies within 3 feet of the surface.

The phase is quite variable, and includes patches of loam, silt loam, and fine sandy loam too small to be shown separately on the soil map. In a few instances small spots of sand and fine sand are included.

The Gloucester sandy loam, shallow phase, occurs chiefly in the vicinity of Moon; smaller areas occur northwest and east of Wausau, about 5 miles southeast of Rothschild, and along the Portage County line. All the phase lies within Marathon County. The surface usually is rolling. On account of this topography and the underlying gravelly material the natural drainage is thorough, and in places somewhat excessive.

The original forest growth consisted chiefly of hardwood and hemlock, the greater part of which has been removed. There was some pine mixed with the hardwood, but this also has been removed.

Very little of this phase is under cultivation. In agricultural value it is inferior to the Gloucester fine sandy loam, shallow phase, from which it differs chiefly in being underlain by beds of angular gravel and in being more droughty. Most of the general farm crops give fair yields, but the soil needs careful management to produce profitable crops. For improvement it requires the same treatment as the other light-textured soils of the area.

GLoucester FINE SANDY LOAM, ROLLING PHASE.

The surface soil of the Gloucester fine sandy loam, rolling phase, to an average depth of about 10 inches, consists of a light-brown or yellowish-brown, rather compact, fine sandy loam, containing a fair amount of organic matter. The surface soil of cultivated fields when thoroughly dry is rather grayish. The subsoil consists of a fine sandy loam to sandy loam, which becomes somewhat coarser in texture and somewhat lighter in color with increase in depth. In a number of places the deep subsoil below about 24 inches is sand and gravel.

Gravel in varying quantities is scattered over the surface and mixed with the soil material, the quantity usually increasing with depth. In some places the deep subsoil is so gravelly that it is difficult to penetrate with the soil auger. The phase as a whole is quite stony, the stones ranging from a few inches to several feet in diameter.

There are a number of variations in this soil; one which is quite common is in the color of the subsoil. In many places the subsoil is reddish brown instead of yellowish. The texture of the subsoil also is somewhat variable, and in places the material at a depth of 20 to 30 inches consists mainly of loam or silt loam. In a few places the surface soil is a silt loam. In general the phase may be considered as intermediate between the Gloucester silt loam on the one hand and the Gloucester sand and fine sand on the other, so that gradations between these soils frequently are encountered. The phase includes also a number of small marshy tracts, occupying

kettlelike depressions. All these variations are too inextensive to be indicated satisfactorily on the soil map. In a detailed soil survey it is probable that most of them could be shown.

This soil has a rather loose, friable structure, and is easily cultivated. It is readily worked into a mellow seed bed. It is much easier to cultivate than the Spencer silt loam.

The Gloucester fine sandy loam, rolling phase, is one of the most extensive soils in the area. It occurs in all four of the counties surveyed. In Clark County the phase is confined to the extreme northern part. In Taylor County it occurs as a belt 3 to 10 miles in width extending from the southwestern corner to the northeastern corner. In Lincoln County it occupies large areas in the central and northeastern sections, while in Marathon County it is confined to the southeastern part. Throughout its extent it is associated with the Gloucester silt loam, and in Lincoln County, especially, it is quite closely associated with the Gloucester fine sand as well as the silt loam. It occurs in rather extensive tracts with smaller outlying areas.

The topography of the Gloucester fine sandy loam, rolling phase, is quite variable, but for the most part it ranges from rolling to broken and hilly (Plate I). Most of the phase consists of a series of knolls and ridges, with intervening kettle holes and narrow valleys in which small marshy tracts and lakes are numerous. The country is distinctly morainic; the soil is confined almost entirely to the terminal moraine which marks the farthest point of advance of the late Wisconsin ice sheet. Associated with this morainic belt are a number of small, irregular-shaped areas where the surface is undulating or only gently rolling. In T. 31 N., R. 1 W., and a few other places in Taylor County, there are small areas of land of this character. Most of the phase, however, in Taylor and Lincoln Counties is quite broken. In the southeastern part of Marathon County it has a less broken topography and may be described as gently rolling to rolling. Because of the relief and the loose, open character of the subsoil the phase is thoroughly drained. In places the drainage is excessive.

The forest growth on this phase consisted mainly of hemlock, maple, and birch, mixed with considerable white and Norway pine. Hemlock was the predominant tree growth, and large quantities of tan bark have been taken from areas of this soil. In some of the lower situations there is a growth of elm, and on some of the ridges a growth of basswood and oak. By far the greater part of the timber has been removed, though in some places there is still considerable hemlock and maple. Much of the type has been burned over by forest fires, giving it a very desolate appearance. Where fires have

not occurred recently there is often a rather heavy second growth of poplar and birch.

While there are quite a number of farms on this phase, by far the greater part is undeveloped. In Taylor County it is settled east of Lublin in T. 30 N., R. 3 W., and in the vicinity of Perkinstown and along the Minneapolis, St. Paul & Sault Ste. Marie Railway between Whittlesey and the north county line. In the southeastern part of Marathon County there are a number of small settlements, and some settlement has been made in Lincoln County on this soil, but no large areas have been cleared. In some instances farms have been in operation for 20 years.

This soil produces heavy yields of clover, timothy, oats, barley, and rye, and good yields of potatoes and corn. Corn is more certain to mature than on the heavier soils, such as the Spencer silt loam. Because of the unfavorable topography, however, the type has not been developed to a great extent, and the rough character of the surface will have a tendency to retard development in the future. In many places the slope is so steep that modern farm machinery can not well be used.

This soil requires a somewhat different type of farming from that followed on other soils of the region. In many places there are small gently rolling areas surrounded by rougher land. These less rolling areas should be selected for the cultivated fields and the remainder of the farm used for grazing.

This soil is well adapted to grasses. The dairy industry could profitably be developed. The phase probably is better suited to the raising of sheep than any other type in the area, and this industry offers good opportunities.

The selling price of land of this character is variable, but averages between \$10 and \$15 an acre, depending largely on the location, topography, and stoniness.

GLOUCESTER FINE SANDY LOAM, SHALLOW PHASE.

The surface soil of the Gloucester fine sandy loam, shallow phase, to an average depth of about 12 inches, consists of a brown or rather dark brown fine sandy loam, the surface few inches containing enough organic matter to give it a somewhat darker color than the remainder of the soil. The subsoil consists of a yellowish-brown fine sandy loam which usually becomes lighter in color and texture with depth, a yellow fine sand often being encountered at depths ranging from 14 inches to 3 feet. The lower part of the 3-foot section frequently is a fine sandy loam, and in a few places the lower subsoil consists of a sandy clay loam. There are some local variations in

texture in both the soil and subsoil, the material ranging from fine sand to loam.

The Gloucester fine sandy loam, shallow phase, is confined entirely to Marathon County. It occurs mainly east of the Wisconsin River between the Eau Claire River and the south county line. Only a few scattered areas are found outside this section. Practically all the phase is within 12 miles of the Wisconsin River.

The topography of the greater part of this phase is gently rolling to rolling, and the natural drainage is good. As mapped about 7 miles east of Schofield, however, the phase is nearly level and rather low lying, and the drainage is poor. The subsoil here shows mottlings of red, yellow, and drab, and is quite compact. It also in many places is heavier than typical, owing to the presence of larger quantities of clay, and in places possibly to the occurrence of ferruginous cementing material. In the poorly drained places boulders are plentiful.

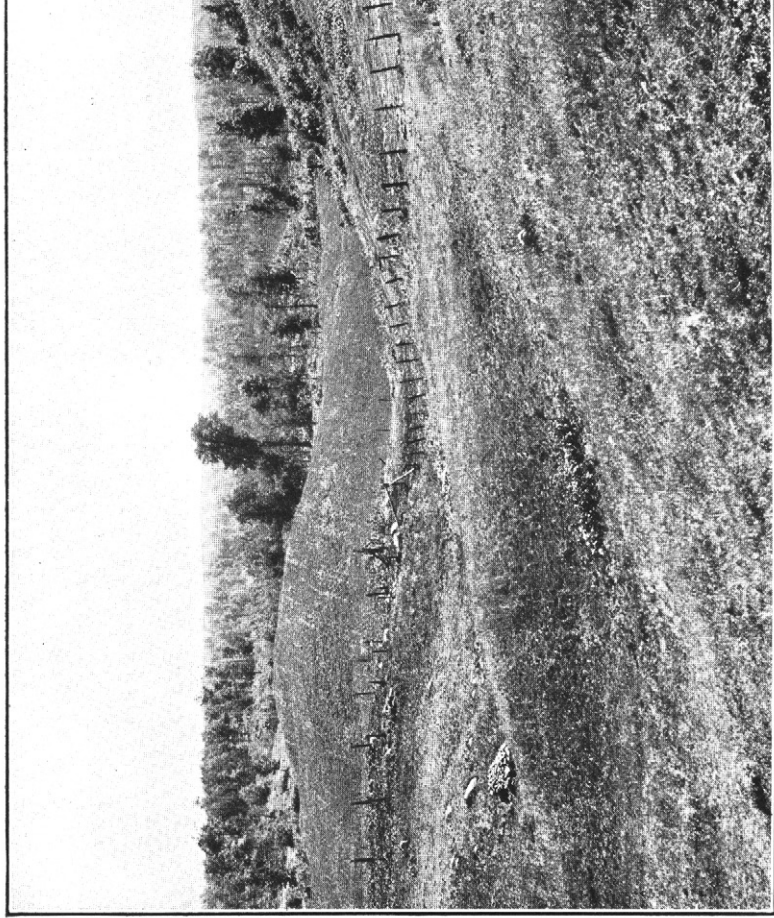
The original timber growth on this soil consisted largely of hemlock and maple, with some pine. There is still considerable hardwood and hemlock standing.

Only a small part of the Gloucester fine sandy loam, shallow phase, has been cleared and placed under cultivation. Most of the development has taken place southeast of Schofield and east of Mosinee. Along the main road east of Mosinee for 8 or 9 miles a large number of 20-acre and 40-acre tracts are being farmed, largely by foreigners who have been located on the land by a large lumber and land company operating in this locality. This type of soil is well adapted to general farming and all the crops commonly grown in this region give satisfactory yields. Small grains, hay, and potatoes and other root crops are the more important crops.

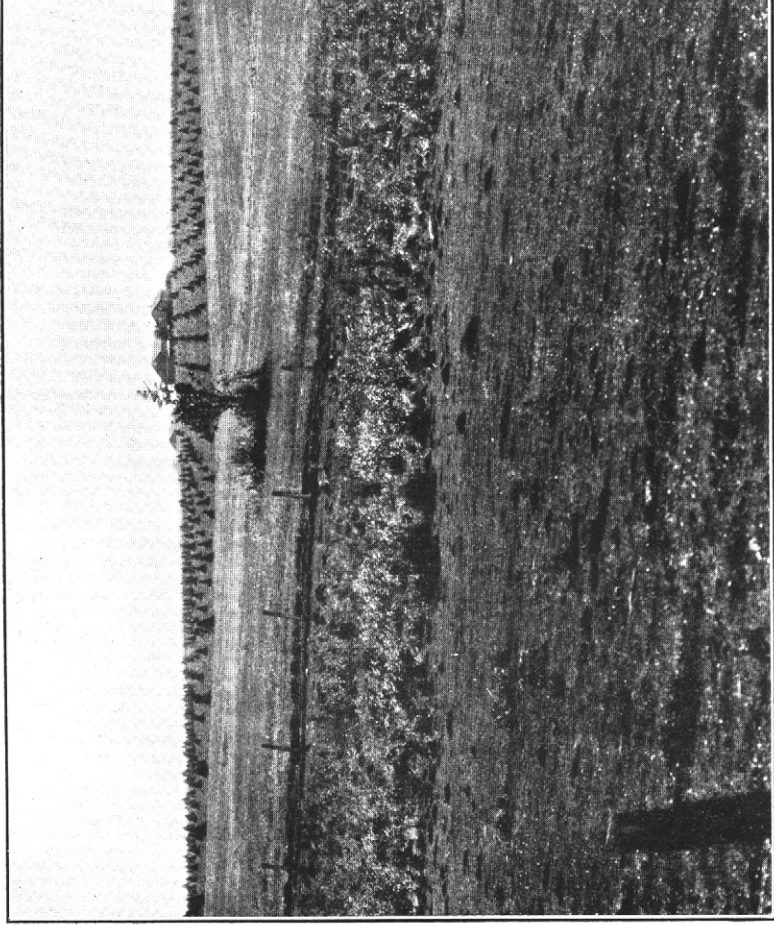
In the improvement of this class of land the supply of organic matter should be increased, and where clover or alfalfa is to be grown the soil should be limed. With proper management the productivity of this soil is easily maintained.

GLOUCESTER LOAM.

The surface soil of the Gloucester loam consists of a brown loam to silt loam containing a moderate proportion of organic matter, with an average depth of 10 inches. The subsoil is a yellowish-brown loam or fine sandy loam, which at a depth of about 24 inches grades into reddish-brown sandy or gravelly clay. At 30 to 36 inches the content of clay becomes much smaller. In Clark County the type to an average depth of 10 to 12 inches consists of a mellow, brown or light-brown loam or silt loam, in which the proportion of fine and very fine sand is relatively large. The subsoil here consists of a lighter colored,



GLOUCESTER FINE SANDY LOAM, ROLLING PHASE, TAYLOR COUNTY



VIEW ON GLOUCESTER LOAM, NEAR NEILLSVILLE, CLARK COUNTY.

Note the gently rolling topography.

yellowish loam or silt loam extending to a depth of 24 to 30 inches, where there usually is an abrupt change to material much lighter in texture, consisting of fine sandy loam, sandy loam, sand, or gravelly sand. Frequently a mass of rather fine sandstone fragments occurs in the subsoil, and in a few instances such material outcrops on the slopes. Glacial gravel frequently is present in the subsoil, and gravel beds are not uncommon. The surface soil, while usually a loam, sometimes contains sufficient fine sand and very fine sand to justify classing the type as a fine sandy loam. These variations, however, can not be separated satisfactorily on the map. In a few instances glacial boulders occur. This type may be considered as an intermediate soil between the silt loam and the fine sandy loam, and variations between these soils may be encountered.

The Gloucester loam type contains some of the best agricultural land in the area surveyed (Pl. II). It occurs chiefly in a north and south belt along both sides of the Black River in Clark County. Several smaller areas are mapped in Lincoln and Taylor Counties.

The surface of the Gloucester loam ranges from gently rolling to steeply rolling, the greater part being rolling. Because of the irregular surface and the open nature of the subsoil the natural drainage is good. There are very few slopes too steep for cultivation, and on the greater part of the type modern farm machinery is used. Some erosion occurs where the slopes are left without a cover crop, but owing to the open nature of the material there usually is very little run-off.

The original forest growth consisted of maple, birch, and hemlock, with considerable white and some Norway pine, especially along the Black River. All the pine has been removed, as well as the best of the hardwood and hemlock.

A very large part of this type in Clark County is cleared and under cultivation, and it is considered one of the best soils in the region. Because of its higher content of fine and very fine sand, it is easier to cultivate than the Spencer soils. Most of the type is highly improved, and devoted to general farming and dairying. Corn, small grains, clover, timothy, and root crops are the principal crops.

Very little of this soil in Lincoln County has been placed under cultivation, but in this section the type is well suited to general farming and dairying and may be expected to develop good agricultural communities.

In the improvement of this soil the addition of organic matter is advisable. It is probable that rock phosphate would also be helpful in maintaining the productiveness. Care should be taken to prevent washing on steep slopes, and attention should be given to the selec-

tion of crop rotations. A rotation commonly practiced consists of corn, followed one year or two years by small grain, which is followed by mixed clover and timothy for two years, when the land is again put in corn. By growing a second crop of clover to be turned under to supplement the available supply of stable manure the productiveness of the type can doubtless be increased.

GLOUCESTER SILT LOAM.

The surface soil of the Gloucester silt loam, to an average depth of about 10 inches, consists of a brown or grayish-brown, or in the upper few inches of virgin areas dark-brown, friable silt loam. The subsoil consists of yellow or light yellowish brown silt loam, which usually becomes somewhat heavier with depth to 20 or 30 inches, where the texture is lighter—a fine sandy loam, sandy loam, or sandy clay loam, usually containing varying quantities of small gravel. The line between the silty covering and the coarser textured subsoil usually is quite sharp. The surface material is comparatively free from gravel, which in the deep subsoil is quite plentiful. Boulders occur on the surface in rather irregular distribution. A number of areas are stone free, and over only a few large areas are stones and boulders present in sufficient quantity to retard or discourage agricultural development.

Some variations occur in this type, chiefly in the depth of the silty covering over the coarser textured material. In a few instances the underlying sandy material outcrops or occurs within several inches of the surface, while in some places the silty covering extends to a depth of over 3 feet. The type includes some areas of fine sandy loam too inextensive or unimportant to be indicated separately on the soil map.

The most extensive areas of the Gloucester silt loam occur in eastern Marathon County, and in western, central, and southeastern Lincoln County. Smaller areas are found in various parts of Taylor County, and in the extreme northwestern corner of Clark County.

The surface ranges for the most part from undulating to gently rolling. In Lincoln County some areas are rolling. The natural drainage is almost everywhere good. Peat marshes are commonly associated with this soil, and along the borders of some of these where the land is low and nearly level the natural drainage is deficient over small areas.

The native forest growth on this soil consisted of maple, birch, and hemlock, with some basswood, oak, and elm. Some white pine and Norway pine were mixed with the hardwood. All the pine has been removed but there is still considerable hardwood and hemlock. Where the land has been cut over the growth consists chiefly of poplar and birch brush.

Only a comparatively small part of this type is cleared and under cultivation, but, with its rolling phase, it gives promise of becoming one of the most highly improved soils in the area. Much of it is still held in large tracts by lumber companies and individuals. Development has taken place on this soil north of Hatley and to the north and south of Norrie in eastern Marathon County, and east of Merrill and in the vicinity of Irma in Lincoln County.

The chief crops are hay, oats, potatoes, corn, and various root crops. Potatoes do well and seem to be especially suited to the soil and climate. Yields range from 150 to 200 bushels or more per acre. Oats yield about 50 bushels and hay from 2 to 3 tons per acre. Clover and all the grasses suited to the climate do particularly well, and along old roads and about all the old lumber camps there is a rank growth of clover and grass. Peas are grown to some extent, and give good yields. Barley, wheat, and sugar beets thrive, but are not grown to any considerable extent in this new country. Corn will mature 4 out of 5 years. Corn for ensilage is a certain crop. The soil is well adapted to general farming and dairying, and is being developed along these lines. It works up readily into a good tilth, and is more easily handled than the Spencer silt loam.

Because of the fact that agriculture on this soil is comparatively new, no definite systems of crop rotation have been worked out. The virgin soil is strong and productive, and the question of maintaining its productiveness has not required serious consideration. The greatest problem is getting the land cleared and ready for the plow. The cost of removing the stones is sometimes equal to the cost of removing the stumps, but it is not necessary that either should be removed from any large proportion of a farm at first. Usually a tract sufficiently extensive for growing the desired cultivated crops is carefully cleared as rapidly as possible and the remainder cleared of the brush and gradually seeded. Good grazing is thus made available, and after a few years the hardwood and hemlock stumps are sufficiently decayed to be readily removed. Where the land is used for grazing the stones are no serious handicap. Probably as much as 40 per cent of the type is either stone free or contains surface stones and boulders in such small numbers that they do not interfere with agricultural development.

The supply of organic matter in this soil is rather limited and easily reduced. As soon as the land is cleared for cultivation attention should be given to keeping up and even increasing the organic-matter supply, as by growing green-manure crops, preferably legumes, to supplement the available supply of stable manure. The use of some form of lime is necessary where alfalfa is to be grown. Liming is also beneficial in growing clover and other general-farm crops, though for these its use is not necessary.

Cut-over land of this type ranges in value from \$12 to \$25 an acre, depending chiefly upon its location. Partly improved farms are valued at about \$35 to \$60 an acre.

Gloucester silt loam, rolling phase.—The surface soil of the Gloucester silt loam, rolling phase, to an average depth of 8 to 10 inches, consists of a brown or light-brown mellow silt loam, which in its virgin state has a fair percentage of organic matter. The subsoil is a yellowish or yellowish-brown silt loam, grading into a heavy silt loam or silty clay loam. At a depth of 16 to 24 inches this passes into coarser textured material, consisting of fine sandy loam, sandy loam, or gravelly loam. Beds of sand or fine sand are encountered in the subsoil in places. The rolling phase is quite similar to the typical soil, except that the covering of silty material is thinner and more irregular. On many of the hilltops and steep slopes the underlying gravelly and sandy material outcrops in small areas, while along the lower slopes there is sometimes a deep accumulation of silt which extends beyond the reach of the soil auger. Stones and boulders are scattered over the surface and mixed with the soil, but their occurrence is not uniform, and there are many stone-free areas. The stones are seldom present in sufficient quantity to interfere with cultivation.

The rolling phase of the Gloucester silt loam is confined almost entirely to Taylor County, though it is encountered also in the extreme northwestern corner of Clark County. It occurs chiefly in the morainic belt which crosses Taylor County from northeast to southwest. There are three large areas of the phase, one in the extreme southwestern part of Taylor County, west of Lublin and south of Polley; one several miles northeast of Perkinstown; and the third in the extreme northeastern corner of the county.

The phase differs considerably from the typical soil in topography. The surface varies from rolling to rough and broken, and over a large part of the land is so steep that modern farm machinery can not be used. Potholes, in which small areas of Peat may be found, and lakes and ponds are quite numerous. On some of the ridge tops there is frequently some nearly level land, while in other places the tops of the ridges are very narrow. The natural drainage is thorough to somewhat extensive. When cleared, many of the steeper slopes will probably erode unless steps are taken to prevent it.

The original forest growth, as on the typical soil, consisted of maple, birch, and hemlock, with a mixture of white and some Norway pine. Much of the land has been cut over, but considerable hardwood and hemlock timber remains.

By far the greater part of this phase is unimproved. The greatest development has taken place west of Lublin. The soil is adapted to the same crops as the typical soil, but its cultivation is somewhat

more difficult because of the rougher topography. The crops grown and the yields obtained are about the same as on the typical soil, and the same methods are needed for its development and improvement.

Gloucester silt loam, shallow phase.—The surface soil of the Gloucester silt loam, shallow phase, to an average depth of 10 to 12 inches, consists of a yellowish-brown, friable silt loam. There is sufficient organic matter in the surface few inches to give the material a somewhat darker color than the underlying soil. The subsoil consists of a yellow or yellowish-brown silt loam. With increase in depth the material gradually changes to a silty clay loam, which extends to a depth of 30 or 36 inches and is underlain by yellow sandy clay, clay loam, or fine sandy loam. This phase seldom has the heavy, compact subsoil layer characteristic of the Spencer soils, as the angular gravel and other rather coarse material scattered through the subsoil make it somewhat more open and permeable.

In texture and general surface characteristics this phase is uniform over large areas, but there is some variation in the depth of the extremely silty surface soil. In the vicinity of Halder the soil is less deep than elsewhere and is underlain by a bed of angular gravel from disintegrated granite, known as arkose. Much of the type north of Marathon, north of Wausau, and between Sunset and Glandon contains disintegrated particles of the bedrock in the lower subsoil. Along the ridge tops and on some of the steep slopes the bedrock often outcrops and frequently is encountered at a depth of 2 to 3 feet. Most of the type is practically free from glacial boulders. In some places angular rock fragments are scattered over the surface and mixed with the soil.

The Gloucester silt loam, shallow phase, is confined entirely to Marathon County and is one of the most extensive and important soils in the area. It occurs in an almost continuous body, near the center of which the city of Wausau is situated. East of the Wisconsin River it extends nearly to Hogarty and occurs largely north of the Eau Claire River. On the west side of the Wisconsin River the phase extends to a point about 2 miles east of Stratford, and farther northward it extends west of Edgar.

The surface of this phase is generally rolling, with some areas gently rolling. The hills and ridges usually are broad, with long slopes. While there are some slopes too steep to be cultivated easily, modern farm machinery can be used on nearly all parts of the phase. The soil is thoroughly drained, and where beds of gravel occur the drainage frequently is excessive.

The original forest growth on this soil consisted chiefly of hardwood, with maple as the predominant growth. Birch was quite plentiful in places, and there was considerable hemlock. Some pine

was found, and in places it made up a large proportion of the tree growth. Most of the best timber has been cut, but there are still some rather extensive tracts of hardwood and hemlock, and many woodlots on improved farms.

The Gloucester silt loam, shallow phase, includes the best extensive areas of farm land about the city of Wausau. Its steady development has an important influence on the continued growth of this city. The soil is well suited to all the general farm crops adapted to the climatic conditions. Hay, small grains, root crops, potatoes, and corn for fodder or ensilage do well. The phase is especially suited to grasses, and clover makes a luxuriant growth on new land.

In the further development of this land attention should be given to increasing the organic-matter supply. A part of each farm could profitably be limed in order to grow alfalfa and to insure continued success with clover. The application of rock phosphate is advantageous in maintaining and increasing the productiveness of this soil.

SPENCER SERIES.

The Spencer series includes the light-colored upland soils in the glaciated region, where the underlying material is usually heavy and extremely compact. The subsoils, and in some places the surface soils, are mottled to a marked degree. The surface varies from nearly level to undulating and gently rolling, with long, gentle slopes. Because of the surface features and the heavy character of the subsoil, the natural surface drainage is often poor and the internal drainage is always deficient. This series differs from the Gloucester in having a much more compact and impervious subsoil and in being less broken in topography and less stony. It is found chiefly in the region of the older glacial drift, but may also occur within the limits of the recent Wisconsin glaciation, where it appears that the last ice sheet moved over the surface without leaving any large deposit and modified the surface to only a very small extent. The Spencer soils are derived mainly from material resulting from the disintegration of the underlying crystalline rocks, although a large part of the material was brought to its present position by one or more glaciers, and the silty surface soil is derived partly from the loess or loesslike material that occurs over a large part of north-central Wisconsin. The mottling is partly due to poor drainage. Both the surface soils and the subsoil show varying degrees of acidity.

SPENCER LOAM.

The Spencer loam is extremely variable, ranging in texture from a silt loam to a fine sandy loam, but because of numerous changes in texture within short distances and because the soil is prevailingly a

loam the variations are not separated. In a detailed survey it might be practicable to separate several types.

In general the surface soil consists of 12 inches of brown or dark-brown loam, the material in many places being yellowish or reddish brown a few inches below the surface. The subsoil usually consists of a reddish-yellow sandy clay loam, which frequently becomes heavier with depth and is mottled with drab, brown, and yellow. In a few places the subsoil contains considerable mica and some chlorite. At a depth of about 4 feet decomposed mica and chlorite schist is encountered. South of Ringle the subsoil contains considerable angular granitic gravel and is not mottled, doubtless because of better drainage.

The Spencer loam is confined entirely to Marathon County. The most important areas are in the vicinity of Ringle and about 8 miles east of Mosinee.

The original forest growth consisted of hardwoods, chiefly maple, and hemlock. The greater part of the merchantable timber has been removed and the land left in "slashings."

Very little of this type has been placed under cultivation. Before farming operations can be carried on successfully it is necessary to provide good drainage. The use of tile drains is profitable, and often necessary. With thorough drainage this is a productive soil. On the new land clover makes a vigorous growth, but after crops have been grown for a time the use of lime is beneficial. For growing alfalfa liming is necessary. Areas cleared of brush afford good grazing.

SPENCER SILT LOAM.

The surface soil of the Spencer silt loam consists of a gray or grayish-brown, smooth-textured heavy silt loam, 10 inches deep. When the soil is dry it has a gray, ashy appearance, the light color being due to the low content of organic matter. In some cases the surface soil has a larger accumulation of organic matter than typical and is brown or dark brown in color. In some instances the lower part of the surface soil is slightly mottled.

The subsoil consists of a heavy silt loam of grayish or yellowish color. It gradually becomes heavier with depth, grading into a silty clay loam or clay loam at about 14 or 16 inches. This heavy material, which is very compact, extends to a depth of about 30 or 36 inches, where fine and medium sand, in varying quantities, and in places angular or rounded gravel are commonly mixed with it, forming a gritty clay loam. This frequently extends to great depths, though the underlying rock may be encountered at a depth of 4 feet or more. The subsoil is strongly mottled. Colorings of yellow, blue, gray, red, and rusty brown are common. In a number of places

the deep subsoil consists of red clay, and frequently a large part of the soil section has a reddish cast. The structure of the subsoil of this type is peculiar. The proportion of silt and clay to the coarser material is such that it is very impervious. When dry it does not crack, as do many heavy clay soils. The type is much more difficult to handle than many soils containing as much or more silt and clay. It is more difficult to cultivate than any other type in the area, and in order to obtain a mellow seed bed plowing and subsequent cultivation must take place when moisture conditions are most favorable.

In texture, structure, and color the type is very uniform. There are a few variations, however, chiefly in depth. In a few places sandstone rock is encountered at depths of 18 inches to 3 feet. In some sections this sandstone has weathered into a sand, and in some cuts it outcrops. Where areas of this soil are sufficiently large to be mapped separately they are classed as the Vesper silt loam. Some stones occur on the surface of the type in places, but large areas are stone free, or practically so.

The Spencer silt loam, with its rolling phase, is the most extensive type of soil in the area surveyed. It occurs in all four counties, but is most extensive in Marathon and Clark Counties. It is found in all parts of Clark County, except along the western and southern borders. In Marathon County it is most extensive in the western and northern parts, the largest continuous area occurring in the vicinity of Spencer. In Taylor County the type occurs in the western and northwestern parts, and also in the southern and southeastern sections. In Lincoln County it is confined chiefly to the western and southwestern parts.

The surface of the Spencer silt loam is level or very gently undulating (Pl. III, fig. 1), and because of the surface features and the extremely heavy character of the soil and subsoil the natural drainage is deficient. Some of the lower areas where the surface is level and where the land has not been cleared and placed under cultivation are semimarshy. In the spring and early summer a few inches of water sometimes stands in such places for a considerable period. In a few instances a sufficient amount of organic matter has accumulated to give the soil a rather dark color. Where this condition is very pronounced over sufficiently large areas the soil is mapped with the Whitman series. When these flat, semimarshy tracts are cleared and placed under cultivation the drainage conditions improve to a marked degree even without the installation of extensive drainage systems. The type as a whole, however, is cold and late in the spring, and the planting of crops is frequently delayed because of the soggy condition of the land. Where the type has a gentle slope the land can be cultivated earlier in the spring and to better advantage than where the surface is flat. While large areas of this land are under cultiva-

tion and fair to very good crops are produced, the soil can not be developed to the highest degree without artificial drainage. In practically all cases there is probably sufficient fall to establish drainage by gravity, but the soil is so compact that water moves very slowly through it, and this necessitates placing tile drains close together.

The native forest growth on the Spencer silt loam consists chiefly of hardwood and hemlock. The hardwoods include maple, birch, basswood, elm, ash, and some oak, the ash and elm being confined to the poorly drained sections. White pine and Norway pine were scattered throughout the hardwood, and in a number of places the predominant growth was pine. All the pine has been removed, but large areas of hardwood and hemlock remain. The unimproved cut-over land often supports a rather dense second growth of poplar and birch.

A large part of the Spencer silt loam is under cultivation. The type is naturally productive, and its development has been retarded chiefly by the poor drainage conditions. General farming and dairying, to which the land is well adapted, are the leading types of farming. Grasses do particularly well and supply good grazing. Clover usually does well on new land, in spite of the fact that the soil is acid. After the land has been cultivated for a number of years, however, it is difficult to grow clover successfully. Timothy and alsike do well, but alfalfa will not succeed without the use of lime. Corn and small grains, such as oats and barley, give very satisfactory yields where fair drainage is provided. Corn can usually be matured, though it is sometimes damaged by early fall frosts. It can always be depended upon for ensilage.

For its improvement this soil requires thorough drainage and thorough cultivation. The surface drainage may be greatly improved by plowing fields in narrow strips, leaving dead furrows running with the slope at intervals of 2 or 3 rods. These may connect with open ditches along the margins of the field. This type of drainage is often sufficient, and while the land is new and where the amount of available capital is small it probably is the best system to use. Ultimately the level or nearly level areas may be profitably improved with tile drains.

This soil should be plowed only when the moisture conditions are favorable, and subsequent cultivation should be sufficiently frequent to maintain a good surface mulch. When handled under favorable moisture conditions a very mellow seed bed is readily obtained. The amount of organic matter in the surface soil is rather low and should be increased by supplementing the stable manure with green-manure crops, preferably the legumes. Applications of ground rock phosphate have given good results on this class of land. A rotation of crops which appears to be well suited to this type con-

sists of small grains, with which clover and timothy are seeded and hay cut for two years, after which the land is used for corn and then returned to small grain. The use of lime is beneficial in the growing of clover and necessary in the growing of alfalfa. Lime is also advantageous in growing other general farm crops, such as corn and small grains. Most of the general-farm crops, with the exception of clover and alfalfa, make a satisfactory growth on this soil, and such legumes as soy beans and serradella can be grown successfully under acid conditions, so that it is possible to carry on a good system of farming without the use of lime.

Spencer silt loam, rolling phase.—The Spencer silt loam, rolling phase, differs from the typical soil chiefly in topography, and as the change from one to the other usually is very gradual the line of separation is often arbitrarily drawn, and small tracts of the typical soil are included with the rolling phase, and vice versa.

The Spencer silt loam, rolling phase, to an average depth of 8 or 10 inches, consists of a gray or grayish-brown, smooth-textured heavy silt loam, with a relatively high content of silt and only a small percentage of organic matter. When the soil is dry it has a gray, ashy appearance, and where organic matter has accumulated, as in low-lying areas, the color frequently is dark brown. The subsoil consists of a heavy silt loam of grayish or yellowish color, which grades into a silty clay loam or clay loam at an average depth of 14 inches. This heavy, compact material commonly contains varying quantities of medium sand and fine angular or rounded gravel below a depth of about 30 inches, giving it a gritty feel. The gritty material usually extends to great depths, though in a few cases the underlying rock is reached within 4 or 5 feet of the surface. Both the soil and subsoil of this phase are very uniform, and in texture, color, and structure closely resemble the typical soil. The subsoil, however, is seldom mottled and the upper part is not so strongly mottled as in the typical Spencer silt loam. In the lower depths, however, the mottling usually is quite pronounced, and is practically the same in type and phase. As in the typical soil, the lower subsoil sometimes consists of heavy red clay, and a reddish cast frequently prevails throughout the subsoil section. The peculiar structure of the typical soil is also seen in the phase, but is not so objectionable in retarding drainage, because of the more uneven character of the surface.

A few small areas of this phase are underlain by Potsdam sandstone, which in places lies within reach of the 3-foot soil auger. Such areas are not large enough to warrant separation on the map. The underlying formation throughout this region consists almost entirely of crystalline rocks.

Some stones and a few boulders are scattered over the surface in many places, though seldom in sufficient quantity to interfere with cultivation. The stones are generally rounded, indicating glacial origin, but where the phase adjoins soils of the Gloucester series there frequently are some angular fragments of rock on the surface. In no place are stones as plentiful as on the soils of the Gloucester series. Extensive areas are practically stone free.

The largest areas occur in western and northern Marathon County, southern and western Lincoln County, throughout Clark County except in the western and southwestern parts, and through the eastern and southeastern sections of Taylor County. There are a few small areas in the northwestern portion of Taylor County in the vicinity of Jump River.

The surface of the rolling phase of the Spencer silt loam varies from very gently rolling to rolling (Pl. III, fig. 2). The areas always have a more pronounced slope than the typical soil, and the separation is made on this basis. There is in all places sufficient slope to provide fair to good surface drainage. Because of this difference the phase has a somewhat higher agricultural value than the typical soil. Owing to the heavy character of the subsoil, however, the movement of water through the soil is very sluggish, and in low places and even on some of the slopes the installation of tile drains doubtless would prove profitable. Along the lower slopes where the drainage is somewhat poorer than elsewhere the mottling in the subsoil is more pronounced. The slopes are not steep enough for destructive erosion. Modern farm machinery can be used in all places.

The original forest growth on the phase is very similar to that on the typical soil, except that there is less elm and ash, which are more abundant on poorly drained land. Maple and birch formed the greater part of the original growth, but there was also considerable hemlock, and in some places white pine was the dominant growth. Upon the northernmost part of the phase there is still a heavy forest. Where the land has been cut over and is neither improved nor grazed there is often a second growth of poplar and birch.

A larger proportion of the phase is under cultivation than of the typical soil, and the land is more highly improved. This is probably due to the fact that it has better drainage, can be worked earlier in the spring, and gives higher yields. This is a very good general-farming soil, and the dairy industry is highly developed upon it. It supports the most highly developed communities in the area. The soil is especially well suited to grasses. Clover makes a good growth on new land, even though the soil seems acid. After fields have been cultivated for a number of years clover does not do quite so well without the use of lime.

The leading crops are timothy and clover, oats, and barley, with a small acreage of wheat, corn, and potatoes. The small grains do very well on this soil. Corn makes a satisfactory growth, but in some years early fall frosts prevent the maturing of the crop. Corn can always be depended upon to produce ensilage. Potatoes usually yield well, but the soil is rather heavy for growing this crop on a commercial scale.

For its improvement this soil requires the same treatment as the typical Spencer silt loam, except that the question of drainage is not so important. There are only a few places where underdrainage is necessary, and these are confined to depressions and the lower parts of the slopes. The organic-matter supply is rather low and should be increased by plowing under green-manure crops and applying all available stable manure. The application of phosphorus will be found profitable. Where alfalfa is grown liming is necessary, and liming results in somewhat increased yields of corn and the small grains. Small grains, corn, and potatoes can be grown successfully, however, without the use of lime, and such legumes as soy beans and serradella make a good growth on acid soils.

The value of farms on the Spencer silt loam, where well improved, ranges from \$75 to over \$100 an acre. Cut-over, unimproved land can be bought for \$15 to \$25 an acre, depending upon its location.

WHITMAN SERIES.

The soils of the Whitman series are brownish gray to almost black at the surface, grading into lighter grays mottled with yellows and browns in the subsoils. The soil and subsoil often contain stones and small boulders. The topography is flat or depressed, the soils occurring as narrow strips bordering small streams where drainage is imperfectly established or as basin-shaped areas not connected with stream drainage. The soils are formed from glacial till, or to a less extent from glacial-lake and river-terrace material, and are developed where the lack of drainage favors the accumulation of organic matter but in quantities insufficient to produce Muck. A slight amount of material is also probably contributed by wash from higher lying areas as alluvium, though this source of supply is usually of minor importance. The soils are often found intervening between Muck areas and the upland, in this respect corresponding to some of the nontypical areas of Clyde soils which have in the past been mapped in some of the northern and central States.

WHITMAN FINE SAND.

The surface soil of the Whitman fine sand consists of about 12 inches of a dark-brown or black fine sandy loam or medium to

fine sand containing considerable organic matter. The subsoil is somewhat lighter colored and heavier textured, usually a mottled yellow and drab fine sandy loam to a depth of about 18 inches. Below this a reddish color is sometimes found and the texture is a fine sand or sand, usually extending to a depth of more than 3 feet. In places the subsoil is underlain by gravelly material. The type is quite variable, but because of its small extent its variations can not be indicated satisfactorily on the soil map.

The Whitman fine sand is confined in general to the southern and southwestern parts of Clark County. A few small areas occur in Marathon and Lincoln Counties.

The surface of this soil is flat, and because of its low position the natural drainage is poor. Much of the type is subject to overflow. In some places the type may extend up a gentle slope where seepage keeps the ground wet. This soil consists largely of alluvial material occupying flood plains of streams or low terraces.

The original forest growth varied from place to place. In the better drained areas there was some hardwood, and where drainage conditions were poorest there was only a growth of coarse grasses or willow and alder.

Because of the poor drainage conditions prevailing over this type, it has not been cleared for cultivation.

WHITMAN SILT LOAM.

The surface soil of the Whitman silt loam consists of 10 or 12 inches of a dark-gray to black silt loam, usually containing a large quantity of organic matter. The subsoil is a gray, heavy silt loam which with increase in depth gradually becomes heavier. At about 20 inches the material is a silty clay loam or clay loam, usually strongly mottled with red, yellow, and brown. The subsoil is heavy and compact and usually extends to a depth of more than 3 feet.

In texture and structure the soil section is variable, and in many places the color of the surface soil is considerably lighter than the average. In a few places the subsoil below about 2 feet consists of sandy clay. In a few instances beds of stratified sand occur in the lower subsoil. These variations, however, are of small extent. In general the lighter colored part of the type is confined to Clark and Taylor Counties and the western part of Marathon County, although in these places the dark soil also occurs. The part having the lightest textured subsoil occurs in regions where the uplands are more or less sandy. In a few instances, especially in Marathon and Lincoln Counties, there are small, isolated areas in which stones and boulders are very plentiful. Some of these areas in Lincoln County are indicated on the map by symbols.

The Whitman silt loam is rather widely distributed through the four counties surveyed. The areas mapped usually range in size from 40 acres to 3 or 4 square miles, though a few are somewhat larger. The surface is level or very gently sloping. The type usually occurs in narrow strips along the flood plains of streams or as rather small, depressed areas in the upland. It occupies a position similar to that of the Clyde soils. Because of the heavy character of the material and its low position the natural drainage of the type is poor.

The forest growth on the Whitman silt loam includes a great variety of trees. Ash and elm are common in some places, especially where the drainage is poorest. Over the better drained areas there is some birch, maple, and hemlock. In some places there is no large timber, but a dense growth of willow or alder. In a few places there is a heavy growth of marsh grass.

On account of its low position and poor drainage, very little of this type has been improved. A few small fields have been cleared and placed under cultivation, but because of its wet condition in the spring the soil is very difficult to put in cultivated crops. Marsh hay is cut from a few places and is at present the most important crop. With good drainage this soil should prove to be very productive and well suited to general farming. Without drainage it is doubtful whether it can be utilized, except as hay and pasture land.

MERRIMAC SERIES.

The types of the Merrimac series have brown or light-brown surface soils, underlain by yellow or yellowish-brown subsoils consisting of stratified sand or sand and gravel. The material is of alluvial origin, having been deposited in the form of outwash plains, stream terraces, or filled-in valleys. The parent material has been derived from crystalline rocks. The soils are commonly acid. The surface is level, and the heavy types frequently have poor drainage. This series is quite extensively developed in the present survey.

MERRIMAC SANDY LOAM.

The Merrimac sandy loam consists of 8 or 10 inches of brown sandy loam, resting on a subsoil usually consisting of reddish-brown or rust-colored sandy loam, which at a depth of about 2 feet grades into a reddish gravelly sand. At a depth of about 3 feet the material commonly has a yellowish cast, and the lower part of the subsoil usually is stratified, lenses of gravel and coarse and fine sand being common. In a few places some sandy clay or clay loam occurs at a depth of about 30 inches.

The type is subject to some variation in texture. The area near Bevent is somewhat heavier than typical and contains patches of

soil approaching loam. In other places the texture approaches that of a fine sand or fine sandy loam. These variations are not of sufficient importance to be indicated on the soil map.

The Merrimac sandy loam is a type of minor importance; it is confined almost entirely to Marathon County. The principal area occurs along the Little Eau Claire River about 4 miles west of Bevent. Small areas occur along the Trap River east of Trap City, along the Wisconsin River south of Merrill, on Kennedy Creek southwest of Wausau, and on the Eau Claire River north of Ringle and about 2 miles northeast of Hogarty.

The surface of this type is level. It occurs as river terraces, and usually lies somewhat lower than the Plainfield sand and gravelly sand, also terrace types. The natural drainage is sometimes deficient. The ground-water level in many places is within 3 feet of the surface, and where this is the case the type is rather wet, especially in the spring and early summer. Where the type occurs on a second terrace the drainage is generally fair and sometimes excessive.

The predominant native growth on this soil consisted of white and Norway pine, all of which has been removed.

Only a small part of this type has been placed under cultivation. It has a somewhat higher agricultural value than the Plainfield sand and gravelly sand, but is not so good a soil as the Merrimac fine sandy loam. Most of the general farm crops of the region are grown to a limited extent, but yields are rather low, and the type as a whole is considered of rather low agricultural value.

The organic-matter content of this soil should be increased, and it should either be limed, to assist in growing such crops as clover and alfalfa, or devoted to such legumes as will succeed under acid conditions. The use of commercial fertilizers containing phosphorus and potash probably would prove beneficial. Attention should be given to crop rotation.

MERRIMAC FINE SANDY LOAM.

The surface soil of the Merrimac fine sandy loam type, to an average depth of about 10 inches, is a brown fine sandy loam, though the color of the surface 2 or 3 inches of the virgin soil, owing to an accumulation of organic matter, may be somewhat darker than the remainder of the soil section. The subsoil usually is a yellow sand or fine sand, to a depth of 18 to 24 inches, below which it is somewhat lighter in color and of variable texture, varying from medium sand to fine sand. Throughout the soil section there is a small percentage of gravel and in a few localities a gravel bed is encountered at a depth of about 3 feet. The type is practically free from large stones.

Some variations from the soil as described above occur. Patches of fine sand, medium sand, and sandy loam, too small to map, are included. In a few localities the subsoil is somewhat heavier than usual, and contains an appreciable quantity of silt and clay. In some low places the surface soil is quite dark and sometimes approaches a silt loam in texture.

The Merrimac fine sandy loam is distributed through Lincoln County and the eastern half of Marathon County. The largest area is in the southeastern corner of Marathon County.

The surface of this type is level. Drainage is fair to good, but there are a few places where the ground water is so near the surface that artificial drainage is needed.

The original timber growth consisted of mixed pine and hardwood. In some localities the hardwood predominated, while in other sections the dominant growth was pine. There was also considerable hemlock in places. All the pine has been removed, but some of the type still supports a growth of hardwood and hemlock.

Part of this type has been placed under cultivation, and fair yields are obtained. The soil is well suited to the general farm crops common to the region, and particularly to truck crops, but because of its unfavorable location the truck industry has not been developed.

In the improvement of this soil liming will be found helpful, especially in growing clover. Where alfalfa is grown liming is necessary. The use of lime probably would also result in an increase in the yields of other crops. The type is well suited to potatoes, and for best results a rotation consisting of one year of small grain, one year clover, and one year potatoes should be followed. The amount of organic matter in the soil should be increased by supplementing the available supply of stable manure with green-manure crops, for which purpose the legumes are best.

MERRIMAC SILT LOAM.

The surface soil of the Merrimac silt loam, to an average depth of about 12 inches, consists of a yellowish-brown smooth, friable silt loam. In the surface 2 or 3 inches there is considerable organic matter, which imparts a somewhat darker color than is found in the remainder of the soil section. The subsoil is a yellow or drab silt loam, in many places mottled, extending to a depth of about 2 feet, where a fine sandy loam or sandy loam usually is encountered. This is usually yellowish in color, though it may be mottled with red, brown, and drab. In a few places this lower subsoil is sandy clay loam. At a depth of 20 to 36 inches stratified beds of fine and medium sand usually are present.

This type has a number of variations, especially in the depth of the silty covering over the underlying sand, which ranges from about

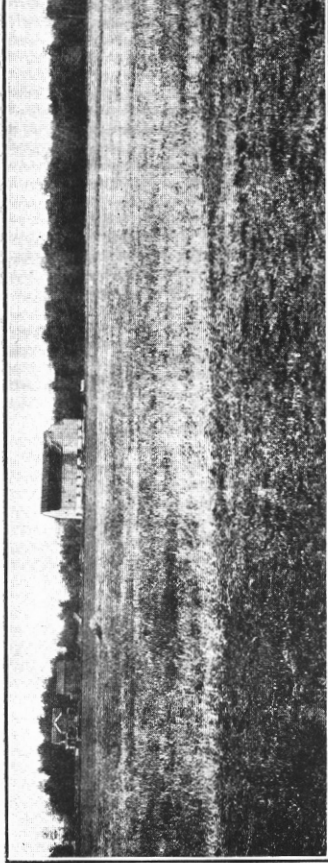


FIG. 1.—SPENCER SILT LOAM, SHOWING NEARLY LEVEL SURFACE AND WELL-IMPROVED PHASE.
 With its rolling phase this is the most extensive and important soil in the area

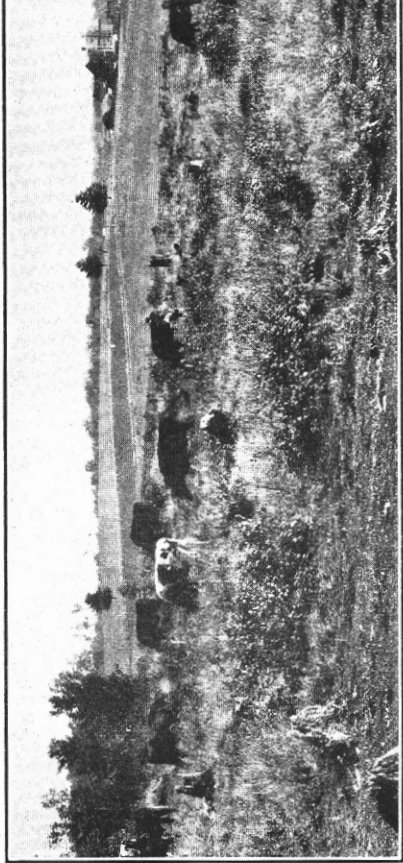
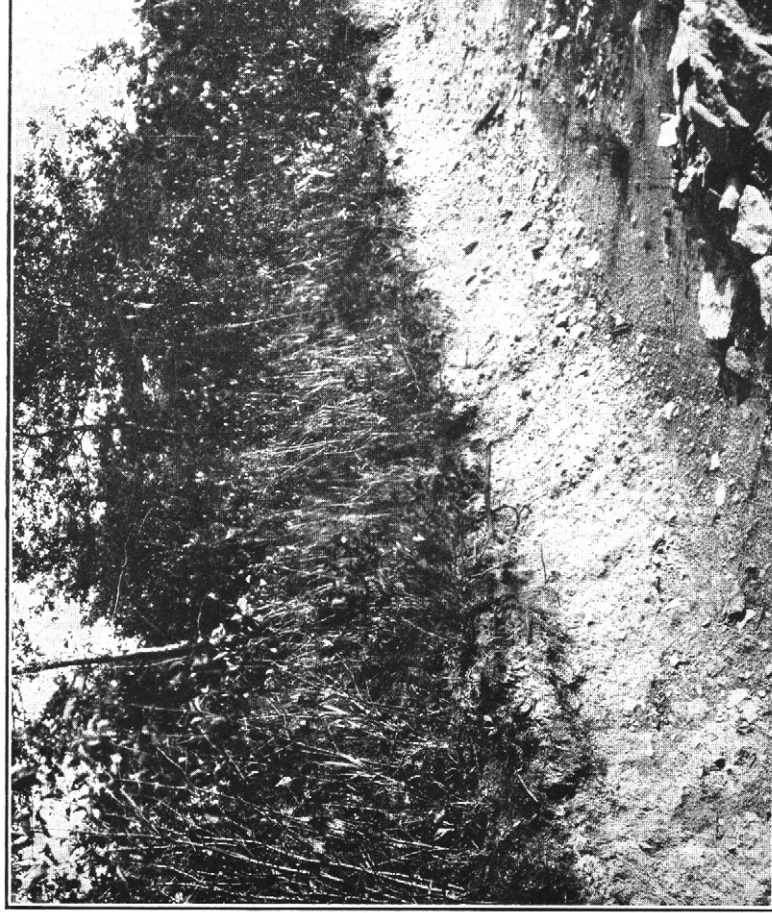


FIG. 2.—SPENCER SILT LOAM, ROLLING PHASE.
 Note characteristic gently rolling surface and typical well-improved farmland



ROAD-CUT IN THE BOONE FINE SANDY LOAM, POORLY DRAINED PH
This shows the presence of fragments of the sandstone from which this soil is d

10 inches to 4 or 5 feet. These extremes, however, rarely occur, and the average depth of the silt is about 24 inches. The silt covering is deepest in Tps. 31, 32, and 33 N., Rs. 7 and 8 E., where it has a depth of about 30 inches. In Tps. 26, 27, and 28 N., R. 10 E., the underlying sandy material usually lies within 20 or 24 inches of the surface.

The Merrimac silt loam is confined almost entirely to the eastern sections of Lincoln and Marathon Counties. It is not an extensive type.

The surface of this soil is level, and where the silty covering has a depth of 2 feet or more the natural drainage is somewhat deficient, particularly in areas adjoining a stream or lying on rather low terraces. In such places tile drainage should prove beneficial. Where the soil is well elevated the underlying sand and gravel affords excellent drainage.

This is a hardwood soil, the original timber consisting chiefly of maple and birch, with considerable hemlock and some white and Norway pine. All the pine has been removed, but considerable hardwood and hemlock remain.

The Merrimac silt loam is recognized as one of the best soils in the area. Its freedom from stones and bowlders makes it much more desirable than some of the rolling land, and the sandy subsoil makes the removal of stumps comparatively easy. It is easily worked, and no difficulty is encountered in providing drainage. The type is well adapted to the general farm crops of this region, and is certain to attain a very high state of development. The crops grown at present consist of clover and timothy, small grains, corn, and potatoes, all of which give fair to good yields.

Liming will be found beneficial for clover and necessary where alfalfa is to be grown. It should also tend to increase the yields of other crops. The organic content should be increased by supplementing the stable manure with green-manure crops, preferably the legumes.

PLAINFIELD SERIES.

The Plainfield series includes the light-colored, forested soils of alluvial origin which have been deposited as outwash plains, stream terraces, or filled-in valleys. The parent material in most States is derived from sandstone rocks. In Wisconsin, however, for local reasons no distinction is made between the light-textured Plainfield and Merrimac types, the latter being derived in part from feldspathic rocks. In this State therefore the Plainfield sand types may be derived either from sandstone or in part from sandstone and in part from feldspathic crystalline rocks. In the present survey the parent material is derived in part from crystalline rocks.

PLAINFIELD GRAVELLY SAND.

The surface soil of the Plainfield gravelly sand to an average depth of about 8 inches consists of a brown or dark-brown gravelly sand, which is quite loose and open, the surface inch or two of the virgin soil, owing to the greater content of organic matter, being somewhat darker than the remainder of the soil section. The sub-soil consists of a reddish-brown gravelly sand, which is very loose and open in structure, but which usually contains sufficient silt and clay to make the material slightly coherent when moist. The gravel particles present range in size from that of a pea to about that of a hen's egg. The lower part of the soil section usually is stratified, and a bed of gravel is sometimes encountered at a depth of about 3 feet.

Included with this type are a number of small areas of Plainfield sand, which differ from the gravelly sand only in the absence of gravel. There are also a few places where the texture of the soil is somewhat finer than usual. These variations are not of sufficient extent to be indicated on the map.

The Plainfield gravelly sand is confined almost entirely to Marathon County. By far the greater part of this soil occurs along the Eau Claire River east of Schofield and along the Wisconsin River between Schofield and Mosinee. A few small areas occur on terraces along other streams.

The surface of this soil is level. Because of the loose, open structure of the material the natural drainage is generally excessive. In a few cases the type occupies a position lower than usual and the ground-water level is within 3 feet of the surface.

The original forest growth consisted largely of white and Norway pine. In places there was a growth of jack pine. All the timber of value has been removed. At the present time there is some poplar and birch and considerable sweet fern.

Because of the loose, open character of this type it is somewhat droughty and has a low agricultural value. Only a small part of the type has been placed under cultivation. The soil contains little organic matter, and unless the soil is given special treatment the yields obtained are low.

In the improvement of this soil organic matter should be added liberally to improve its power to hold moisture. In order to get a good stand of clover it may be necessary to apply lime and commercial fertilizers containing potash and phosphorus. It might be profitable, instead of liming the soil, to grow crops that succeed under acid conditions. Soy beans and serradella are leguminous crops which make a fairly good growth on acid soils and are well adapted

to sandy land. With careful management this soil can be profitably farmed. A rotation of leguminous crops with small grains and potatoes should give good results.

PLAINFIELD SAND.

As mapped in this survey the Plainfield sand is variable. The area at Humbird has a surface soil consisting of a brown sandy loam about 12 inches deep, underlain by a yellow or brownish sandy loam which usually grades into stratified sand below 30 inches. The areas adjacent to the Black River consist of brownish or yellow sand, underlain by loose, open sand which extends to a depth of more than 3 feet. In the other areas mapped the type consists of a brown medium sand with an average depth of about 10 inches, underlain by a reddish-brown sand which is loose and open structured and which may contain considerable gravel. This material extends to a depth of over 3 feet. The lower section is usually stratified and consists of layers of fine and medium sand and gravel.

Most of the variations in this type are of too small extent to be indicated on the soil map. In the vicinity of Bevent the subsoil usually is a yellow, loose sand, but in places it is a reddish-brown sand; there is a much higher content of fine sand in this locality than elsewhere. The underlying beds of gravel which occur in various places sometimes lie within 12 inches of the surface, and in occasional spots the surface soil is so gravelly that it could properly be classed as a gravelly sand.

The principal areas of the Plainfield sand occur in Marathon County, in the valley of the Wisconsin River in the vicinities of Dancy, Mosinee, Granite Heights, and Wausau. Important areas also occur in Lincoln County near Merrill and to the north of Tomahawk. Other areas occur west of Dancy along the Eau Pleine and Little Eau Pleine Rivers, between Wausau and Marathon along Big Rib River, and along the Plover River near Bevent. One area is encountered immediately east of Humbird in southwestern Clark County and others occur along the south Clark County line on both sides of the Black River.

The surface of the Plainfield sand is level to very gently undulating and the natural drainage is good. The material is somewhat droughty. The sandy loam areas have a much better water-holding capacity than the typical soil and are sometimes wet during the spring and early summer. There are only a few places where the water level is sufficiently near the surface to make the drainage deficient.

The original timber on the Plainfield sand consisted almost entirely of pine. In most places white and Norway pine was the

principal growth, while in others jack pine was quite plentiful. All the pine timber of value has been removed.

Only a small part of the Plainfield sand is under cultivation. It is deficient in organic matter and is considered a soil of rather low agricultural value. The leading crops are rye, potatoes, some hay and oats, and a small acreage of corn. Because of the acid condition of the soil it is difficult to get a stand of clover. Profitable crops can be grown only where the land is handled very carefully.

In the improvement of this soil organic matter should be added by growing and plowing under legumes. It may be necessary to use commercial fertilizers and lime. Where a good stand of clover or some other legume can be obtained it is not difficult to maintain a fair degree of productiveness in this class of land. The soil is easy to cultivate and responds readily to careful treatment. The sandy loam variation is a fair soil, and in places it is successfully farmed. The general farm crops common to this region give fair yields. There are some areas of the deep, leachy sand whose development probably is not to be encouraged under present conditions.

PLAINFIELD FINE SAND.

The Plainfield fine sand consists of a brown or yellowish fine sand, 8 inches deep, resting on a subsoil of brown, reddish-brown, or rust-colored fine sand, which usually grades at 18 to 20 inches into yellow fine sand, extending to a depth of 3 feet or more. In a number of places the brownish or rust-colored material continues throughout the 3-foot section. Both the soil and subsoil contain enough silt and clay to make them somewhat coherent when wet. In a few places small quantities of gravel are scattered through the soil and the deep subsoil. Gravel beds, however, are not present. In a few instances a very compact layer of reddish fine sand is encountered at a depth of about 8 inches, apparently cemented by ferruginous material. The surface soil here usually is a whitish or gray fine sand, and the drainage is poor.

One of the largest areas of the Plainfield fine sand is in the northern part of Lincoln County, extending northeastward from Tomahawk along the Wisconsin River. In Marathon County there is an area of considerable size, extending about 7 miles to the southwest of Bevent along the Plover River. In the southern part of Marathon County a large area is mapped along the Wisconsin River. There are several small areas along the Black River in the southern part of Clark County and scattered areas along the Wolf River in the northwestern part.

The surface of this type is level to very gently sloping. Because of the loose character of the soil and subsoil the natural drainage is

usually excessive, except in a few places where the type is low and the ground water rather near the surface.

The original forest growth consisted largely of white and Norway pine, which has been removed. The present growth consists of a few small pine trees and some birch and poplar, with a growth of sweet fern.

Very little of the Plainfield fine sand has been cleared and placed under cultivation. Its agricultural value is slightly higher than that of the Plainfield sand, but it requires careful management to produce profitable crops.

This soil is in need of organic matter. In order that clover or some other legume may be grown it may be found advisable to use lime and also commercial fertilizers containing potash and phosphorus. With an increase in the organic-matter supply there will be but little difficulty in maintaining a fair degree of productiveness. A rotation consisting of a small grain, clover (the second crop to be plowed under), and potatoes should give good results on this soil.

VESPER SERIES.

The most characteristic feature of the Vesper series is that the surface soils typically consist of material of brown or grayish-brown color having a high content of silt and clay. They are underlain by a subsoil of much lighter texture, usually a sand, which at a depth of 18 inches to 36 inches passes into the sandstone bedrock. In some cases the underlying material consists of crystalline rocks, but sandstone is the most extensive underlying formation. In this area the sandy material is derived from the underlying Potsdam sandstone by weathering, while the silty covering may be in part of loessial origin or it may owe its origin entirely to glacial action. In the absence of limestone, both soil and subsoil are strongly acid. The surface of the Vesper types is flat and the natural drainage usually is deficient.

VESPER SILT LOAM.

The surface soil of the Vesper silt loam to an average depth of about 10 inches consists of a gray, grayish-brown, or dark-brown silt loam. The subsoil is a gray, drab, or in places yellowish, heavy silt loam, which may be mottled with brown, green, or bluish colors, and which at a depth of about 20 inches grades quite abruptly into sandy material. This may consist of sand, fine sand, or medium to fine sandy loam. In some instances the underlying sandstone rock is encountered within the 3-foot section. In a few places the sandy material is exposed at the surface.

The subsoil of the area near Greenwood is in most places not quite so heavy as that of the remainder of the type. While the

type includes many variations, these are not of sufficient extent or importance to be indicated separately on the map.

The Vesper silt loam is confined to Clark County. It occurs in two distinct localities, in the extreme southeastern corner of the county and about 5 miles southwest of Greenwood.

The surface of this soil is level to very gently undulating. Because of its low position and the heavy character of the material the drainage is poor and the subsoil is cold until late in the spring.

The original timber included some ash, elm, and other moisture-loving trees, and on the best drained part of the type some maple and birch. At present where not cleared the type supports a growth of small birch brush, poplar, and alder.

A small part of this type is cleared and cultivated, but because of the poor natural drainage the yields usually are low. The area southwest of Greenwood appears to have a somewhat higher agricultural value than that in the southeastern part of Clark County, although no larger proportion of it is under cultivation. In its present condition the soil probably is best suited to the growing of timothy and alsike and to grazing.

The first requirement in the improvement of this soil is thorough drainage. Where there is sufficient fall, as there usually is, tiling will greatly improve the drainage conditions. The addition of organic matter and thorough cultivation will greatly improve the structure of this type.

BOONE SERIES.

The types included in the Boone series have brown or light-brown soils and yellow or grayish-yellow subsoils. The material has been derived largely from the weathering of the Potsdam sandstone formation (Pl. IV), with which there is frequently associated in this area a shaly phase. This shaly material on weathering gives rise to soils high in silt and clay content, while the sandstone gives rise to very sandy soils. Where the shale predominates the surface usually is level or gently undulating, in other places it is gently rolling. Both soil and subsoil of the Boone types show varying degrees of acidity.

BOONE FINE SAND.

The surface soil of the Boone fine sand, to an average depth of about 8 inches, consists of a brown or yellow fine sand, containing little organic matter. The subsoil is a yellow fine sand extending to a depth of 3 feet or more, though in a few places it consists of nearly white fine sand. The underlying sandstone is encountered at any depth below 2 feet, a few outcrops occurring. Around Mentor and to the south of Tioga some gravel, largely crystalline, is scat-

tered over the surface and mixed with the soil. The type here appears to have a somewhat higher agricultural value than where no gravel is present. The occurrence of the gravel is not sufficiently uniform or extensive to warrant a separation of the gravelly areas on the map.

The Boone fine sand occurs mainly west of the Black River in the southwestern part of Clark County. The largest area is near Mentor and Tioga and to the east and northeast of Humbird.

The surface of this soil usually is undulating to gently rolling or, in a few places, rolling. Because of the uneven surface and the loose, open character of both soil and subsoil the natural drainage is excessive and the type is droughty. Along the South Fork of the Eau Claire River and also along Hay Creek there is a narrow strip of this type which has a nearly level surface. The water table here is much nearer the surface than usual, and the soil is less droughty.

The original timber on this type consisted chiefly of white and Norway pine, all of which has been removed. The growth at present consists chiefly of scrub oak, with some second-growth pine and an undergrowth of sweet fern.

Only a small part of the Boone fine sand has been put under cultivation. The chief crops are corn, rye, potatoes, and clover. Yields are rather low and the type as a whole may be considered as having a low agricultural value.

In the improvement of this type an effort should be made to increase the organic-matter content by growing and plowing under legumes. In order to get legumes, especially clover, established it may be necessary to use lime and also commercial fertilizers containing potash and phosphorus. By plowing under a crop of clover occasionally and planning a definite crop rotation adapted to sandy soils fair returns may be expected from this class of land. A rotation that should give good results consists of a small grain followed by clover, the second crop of which should be plowed under, followed by potatoes.

BOONE FINE SANDY LOAM.

The Boone fine sandy loam consists of 8 or 10 inches of light-brown fine sandy loam, usually underlain by yellow or yellowish-brown fine sandy loam. In places the subsoil has a reddish appearance, usually near the sandstone mounds where the soil is rather shallow and where the underlying rock is reddish.

The type is subject to considerable variation. In a number of places the surface soil approaches a loam in texture, while the subsoil frequently consists of a heavy fine sandy loam or sandy clay loam. The heavy material is encountered chiefly in the northern extension of the type, northwest of Greenwood. There are also a few

small areas which approach the Boone fine sand in texture. The subsoil in a number of places grades into a fine sand at depths of 2 to 3 feet, while in a few places the bedrock is encountered at about the same depth.

The Boone fine sandy loam is confined to the western and southern parts of Clark County. The type is quite closely associated with the Boone fine sand and also with the Gloucester loam, and may be considered an intermediate type between these two.

The surface of the Boone fine sandy loam usually is gently rolling to rolling, and the natural drainage is generally good and in some places excessive. Associated with the type there are large mounds or hills where the underlying rock outcrops to such an extent as to warrant the classification of such areas as Rough stony land.

The greater part of this type northwest of Greenwood supported a good growth of hardwood and hemlock timber, with an admixture of pine. In the southern areas, which are somewhat lighter in texture, there was an extensive growth of pine. By far the greater part of the timber has been removed.

Only a comparatively small part of the Boone fine sandy loam has been cleared and put under cultivation. All the general farm crops common to this region are grown. Satisfactory yields are obtained, especially on that part of the type northwest of Greenwood, which is somewhat heavier than the remainder of the type. The chief crops are small grains, corn, and hay.

This soil is in need of organic matter, and liming is necessary for the successful production of alfalfa. It is advisable also to apply lime for growing clover, although new land gives very fair yields without liming.

Boone fine sandy loam, poorly drained phase.—The surface soil of the poorly drained phase of the Boone fine sandy loam, to an average depth of about 10 inches, consists of a gray or yellowish fine sandy loam, in the surface few inches of which there is a small percentage of organic matter. The texture of the surface soil is somewhat variable, and in small areas it may range from a fine sand to a loam or even a sandy clay loam. The subsoil also is quite variable, but usually consists of a yellow or nearly white fine sandy loam, grading into light-colored clay loam or sandy clay loam. Beneath the surface soil it is quite common to find a layer of gray or nearly white sand, which may extend to a depth of 18 or 20 inches, where a whitish or bluish clay or clay loam is encountered. This clayey layer has a thickness of 1 inch to 10 or 12 inches or more, and frequently is very plastic and impervious. It may grade into another layer of fine sand or may rest upon broken fragments of sandstone rock. Rock fragments are very often encountered in the soil section, and in some places the underlying sandstone lies within 18

or 24 inches of the surface. Under practically all the phase the sandstone is reached within 3 or 4 feet of the surface. In many places small fragments of the underlying rock are present on the surface. The color of the heavy material underlying this soil is extremely variable, and may be gray, yellow, or nearly red; frequently it is strongly mottled.

The Boone fine sandy loam, poorly drained phase, is confined almost entirely to the southwestern and southern parts of Clark County. One belt, 1 to 5 miles wide, extends about 6 miles north and south from Columbia. Another belt, ranging from 2 to 5 miles in width, extends from the Black River east along the Jackson County line to a point within 2 miles of the southeastern corner of this county. There are a few other areas of this phase.

The natural drainage of this phase is generally poor. The surface varies from flat to very gently undulating. The phase usually lies somewhat low, so that the ground water is rather near the surface, and the underlying rock and beds of heavy material are sufficiently close to the surface to keep the soil saturated by checking the downward movement of rain water. During the spring and early summer the soil is very wet. After it has had sufficient time to become thoroughly dry it is subject to drought, as the impervious layer in the subsoil interferes with capillarity.

The original timber over the main part of this phase consisted chiefly of white pine and some Norway pine. This, however, has been removed and there is now a second growth of poplar and a growth of brush, including birch and gallberry. On the small areas in Marathon County the present growth consists chiefly of scrub red oak.

Only a very small part of this soil has been cleared and placed under cultivation. In a few places fields have been cultivated for a few years and then allowed to remain idle because of the low yields obtained. Owing to the deficiency in organic matter and in drainage, the soil has a low agricultural value.

Where this phase is to be improved it should first be thoroughly drained. The supply of organic matter should be increased, and where clover or alfalfa is to be grown the soil should be limed. The use of some mineral fertilizers also will probably be found desirable, if not necessary. Such crops as timothy and alsike can probably be grown successfully without the use of lime. When thorough drainage has been provided and organic matter supplied, it is probable that fair crops of corn and small grains can be grown.

BOONE SILT LOAM.

The surface soil of the Boone silt loam, to an average depth of about 8 inches, consists of a light-brown to dark-brown, smooth, fri-

able silt loam. This is underlain by a yellow, buff, or yellowish-brown silt loam, which grades into a silty clay loam. At about 28 or 30 inches there usually is an abrupt change to a reddish, gritty, sandy clay loam. At a depth of about 3 feet the underlying sandstone, or sand from this rock, frequently is encountered, although the heavy material usually extends to a depth of more than 36 inches. This soil is associated with, and frequently merges into, the Boone fine sandy loam, but it is very uniform.

The Boone silt loam is confined entirely to an almost unbroken tract in the extreme southwestern corner of Clark County, near Humbird. The surface is rolling, and the natural drainage is good. There are some rather steep slopes upon which erosion is likely to occur. The original forest growth consisted chiefly of hardwood, most of which has been removed.

The greater part of this type is in farms. It is a good general farming soil, well suited to all the crops commonly grown in this region. Small grains, corn, hay, and root crops give satisfactory yields.

In the improvement of the type an effort should be made to increase the supply of organic matter. Where alfalfa is to be grown the soil should be limed. The application of lime also insures continued success with clover.

GENESEE SERIES.

The surface soils of the Genesee series are brown or dark brown. The subsoil is brown or yellowish brown, and the material in the lower depths is stratified. This series occurs as first-bottom land. Most of it is subject to annual overflow. The Genesee soils are mainly derived from alluvium washed from the loessial, glacial, or residual soils of the region. Owing to the absence of limestone, the soils are acid. They are not extensive in this area, and agriculturally are relatively unimportant.

GENESEE SAND.

The surface soil of the Genesee sand consists of brown or light-brown, loose, open sand. The subsoil, encountered at a depth of about 8 inches, consists of a yellow or yellowish-brown medium sand, very loose and open in structure. This extends to a depth of 3 feet or more. In the deep subsoil lenses of coarse sand and gravel commonly occur. The texture of this soil is quite variable, and in a number of places it includes small areas of sandy loam or fine sandy loam.

The Genesee sand occurs in Lincoln and Marathon Counties. The principal areas are within the flood plains of the Wisconsin, Eau Claire, Big Rib, Little Rib, Eau Pleine, and Little Eau Pleine Rivers in Marathon County.

The surface of the Genesee sand is level or has a very gentle slope toward the stream along which the type occurs. The soil occurs as

first-bottom land, and is in most places subject to overflow. The natural drainage is poor the greater part of the year. When the streams are low, however, during dry seasons, the soil dries out quickly, and crops would probably suffer from drought.

On the better drained parts of the type there originally was some pine. In the wet areas there is now a growth of willows and other water-loving trees and brush. Some parts of the type have no timber growth.

Very little of this type has been placed under cultivation, mainly because most of it is subject to overflow. The soil is, however, deficient in organic matter and of low productiveness. In order that crops may be successfully grown the land must be very carefully managed, and under present conditions the improvement of this type probably is not to be encouraged.

GENESEE SILT LOAM.

The Genesee silt loam, as mapped in this survey, is extremely variable in texture. Commonly it consists of a light-brown silt loam, underlain at about 12 inches by a yellow or yellowish-brown silt loam which at a depth of 18 or 20 inches usually grades into yellowish fine sandy loam or fine sand and gravel. In some instances the depth of the silty material is much greater, and frequently it extends to a depth of 3 feet or more, in which case the subsoil usually is mottled. In a number of places the sandy layer of the subsoil lies much nearer the surface, and in a few instances the surface soil consists of a fine sandy loam. In general, the type is heaviest where the upland soils consist largely of silt loam, while the sandy areas occur in regions where the upland soils are sandy. Probably the most extensive area of the sandy material is along the South Fork of the Eau Claire River and its tributaries in the western part of Clark County.

The Genesee silt loam is a type of minor importance in this area. In Marathon County a small area is mapped east of Dancy, near the Wisconsin River, and other tracts along the Little Eau Pleine River. A number of small areas occur in Clark and Taylor Counties, mainly along the Black River and the South Fork of the Eau Claire River. This type occurs chiefly as narrow strips of first-bottom land adjacent to streams, and is subject to frequent overflow. Because of its low position the natural drainage is poor. In some instances where the bottom land is one-fourth mile or more in width it might be possible to drain some of the land. In most cases, however, where the bottoms are narrow it will be difficult to install drainage systems without first deepening the bed of the streams. In a few cases where the type adjoins the upland, it is somewhat higher than usual, and here the drainage conditions permit the use of the land for

crop production. In Taylor County this type includes a number of areas, commonly referred to as "beaver meadows," in which the poor drainage is largely due to the construction of dams by beavers.

The native forest growth on this soil is variable, but consists largely of ash and elm. In places there is no large tree growth, but a dense growth of alder and willow. In some places the only vegetation is coarse marsh grass.

This type is not cultivated, chiefly because of its very poor drainage. In some instances marsh hay is cut, and some of the land is pastured.

MISCELLANEOUS MATERIAL.

PEAT.

The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw, fibrous condition, showing plainly the structure of the vegetable growth from which it is derived. In a fibrous condition the material is brown, but with decomposition its color becomes darker, and where thoroughly decayed it is black or very dark brown. Mineral matter may be incorporated with the organic matter, but seldom in sufficient quantity appreciably to affect the texture. In the more extensive areas of Peat there is little or no mineral matter except about the margins, where the proportion is frequently sufficient to form muck. The mucky areas, however, are too small to be satisfactorily separated, and are included with the Peat.

The depth of Peat is variable. The areas in which it is less than 18 inches are separated as a shallow phase. In some places the organic deposits are more than 20 feet deep, and in practically all the swamps with an area of 1 square mile or more the depth is more than 3 feet. It is generally deepest in the center of the areas, and shallowest about the margins.

In the large swamps and marshes where the material is still raw there is very little difference in character between the surface material and the material several feet below the surface. Where conditions have favored rapid decomposition the material at the surface frequently is considerably darker than that at lower depths. A profile section may consist of 8 to 16 inches of black, fairly well decomposed organic matter, underlain by brown or light-brown, raw, fibrous material extending to depths of 3 to 20 feet.

The material underlying the peaty matter is variable, and ranges from sand to silt loam or clay loam. In general, its texture is determined largely by that of the surrounding upland soil. In the regions of silt loam soils the underlying material is unusually heavy and of a light-gray or bluish color. Throughout the sandy sections in practically all cases the peaty material is underlain by grayish or

nearly white fine to medium sand, and in some instances there is considerable gravel mixed with the sand.

Areas of Peat are distributed through all the counties of the survey, but are most extensive in the glaciated regions of southeastern Marathon County, northern, central, and southwestern Lincoln County, and northern Taylor County. In the region referred to as unglaciated there are very extensive tracts in which no Peat occurs. The most extensive areas of Peat are mapped northeast of Hannibal and 7 to 12 miles west of Dancy, along the Little Eau Pleine River. In Clark County large areas lie in the southern and western parts.

Practically all the Peat areas are level, or have only a very gentle slope. The slope is nowhere sufficient to drain the material without the use of open ditches. Most of the areas of Peat are wet the greater part of the year and there is often a few inches of water over the surface in the spring, when heavy rains occur. A large number of the marshes in which Peat occurs, probably representing the greater part of the Peat as mapped, have sufficient slope to be successfully drained. Along the Little Eau Pleine River a drainage district has been established to reclaim a large tract of marsh land, and other extensive drainage projects are being developed, but the total area of Peat actually producing crops is very small.

The native trees of the Peat consist chiefly of tamarack, cedar, and spruce. Some of the marshes do not support any trees or have only a scattered growth of spruce or tamarack. In most of these places the original timber has been destroyed by fire, though a few marshes apparently have always been treeless. On some of the open marshes there is a growth of coarse grass, which is cut for hay, but in most cases the vegetation consists of sphagnum moss, cranberry bushes, and other moisture-loving plants.

The formation underlying the Peat areas consists of sandstone or crystalline rocks and the surrounding upland soils are composed entirely of noncalcareous material. Practically all the Peat is acid.

Agriculture is most highly developed in the southern part of the area surveyed, and it is most likely in these sections that the Peat will first be reclaimed. The first requisite is thorough drainage, and the large marshes can best be developed through cooperation of the landowners by establishing drainage districts. The peat is very high in organic matter and nitrogen, but low in potash and phosphoric acid, and the application of commercial fertilizers containing these elements is beneficial. Where thorough drainage is established and proper methods of cultivation followed this class of land is adapted to the production of a number of crops, including corn, potatoes, cabbage, buckwheat, and timothy and alsike clover for hay. Where

the soil is made firm by rolling small grains can be grown. Good pastures of tame grass can be established on this land.¹

The peaty material itself can be applied advantageously to sandy soils and where areas of Peat adjoin sandy land that is farmed it is a good practice to apply the material in the same manner as stable manure, supplying mineral elements in the form of commercial fertilizer.

Peat, shallow phase.—Peat, shallow phase, is differentiated from the typical soil, solely on the basis of the thickness of the peaty deposit, the maximum in the phase being 18 inches. The underlying material is variable. In regions where the upland soils are heavy the subsoil usually is a silt loam or clay loam, quite strongly mottled. Where the uplands are sandy the material usually is light, consisting of sand or sandy loam, or in some cases fine sand. The depth of the peaty material also is variable, and ranges from 6 or 8 inches to 18 inches. In Clark County this phase includes a few low, sandy islands which are too small to be shown on the soil map.

The shallow phase of Peat is most extensive in the southern parts of Marathon and Clark Counties. It occurs also in scattered areas in the eastern half of Marathon County, with a few small areas in other parts of the survey.

The production of marsh hay is about the only use made of this soil at present. It is used to a small extent for grazing. In its present condition it has a low agricultural value. When drained it will be adapted to the same crops and types of farming as the typical Peat.

ROUGH STONY LAND.

Rough stony land includes areas in which rock outcrops occupy so large a proportion of the surface that it is impossible to grow cultivated crops. While there is some soil between the outcrops, it is usually shallow.

Rough stony land occurs in two sections of the area, one southwest of Wausau, including Rib Hill and Mosinee Hill, and the other in western and southwestern Clark County, including North, Middle, and South Mounds, several areas north of Humbird, and one southwest of Columbia.

The rock-outcrop areas usually comprise the highest parts of the large hills, forming a conspicuous feature of the landscape.

The rock formation on Rib and Mosinee Hills consists of quartzite, and that forming the bluffs in western Clark County of Potsdam sandstone. Where sandstone prevails the intervening small areas of soil consist of sand, fine sand, or fine sandy loam. Where the quartzite rocks occur the soil usually is a silt loam.

¹ See Bull. No. 205, Univ. of Wis. Expt. Sta., on the development of marsh soils.

Small patches of this land are used for grazing. It is very steep, broken, and rocky, and in many places it is difficult for stock to travel over it. In general, Rough stony land may be considered nonagricultural.

SUMMARY.

The reconnoissance soil survey of the south part of north-central Wisconsin covers four counties—Marathon, Clark, Taylor, and Lincoln—and embraces a total area of 4,665 square miles, or 2,985,600 acres. It is situated just north of the center of the State.

The surface of the northern and eastern parts of the area is characteristic of a glaciated region, and ranges from level to rough and broken. Over the remainder of the area the surface is much older geologically and is more mature; the slopes are long and gentle, and there are few lakes and swamps. Elevations within the areas range from about 785 to 1,940 feet above sea level. The summit of Rib Hill is reputed to be the highest point in the State. The greater part of the area is between 1,000 and 1,600 feet above sea level.

The early settlers in this part of the State engaged in lumbering. In 1855 German immigrants began to settle in the region, and agricultural development may be said to date from about this time. Lumbering continued the principal industry, however, for a long period, and is still important in Taylor and Lincoln Counties. Agriculture did not become important until about 1880. About this time the southern part of the region surveyed, including Clark County and parts of Marathon County, was rapidly settled and the land cleared for farming. Throughout the northern part of the area agriculture is rapidly developing wherever the timber has been removed and the land is of good quality.

Three important railway systems and several small lines traverse the area, providing good transportation facilities and connecting with the large and important markets of the Middle West.

Of the four counties surveyed, Marathon and Clark are the most thickly settled and most highly developed.

The winters of this region are long and cold, but the summers are warm, and all crops make a rapid growth. The precipitation is adequate for successful farming, and is well distributed through the year. In the northern part of the survey the length of the growing season is about 110 days, while in the southern part it is about 130 days. Good water is available in all parts of the area, and the climate is healthful.

Within the area surveyed various stages of agricultural development are represented. In the southern part of the survey, in Clark and Marathon Counties, much of the land is highly improved, with

values ranging from \$60 to over \$100 an acre, while in Taylor and Lincoln Counties there are still extensive tracts of virgin hardwood forest. Cut-over land can be bought for \$5 and upward an acre, depending upon the character of the soil and the location. The lightest sandy soils, originally covered with pine, have a low agricultural value, but the cut-over hardwood areas include considerable good land which is capable of high agricultural development. This land can be bought for \$10 to \$25 an acre.

The type of farming chiefly followed consists of general farming in conjunction with dairying. In general, dairying probably is the most important industry in the area. The chief crops grown are oats, hay, corn, potatoes, barley, rye, wheat, peas, and some buckwheat, with small patches of truck crops near the towns. During the past decade agriculture has made rapid progress.

A large part of the area owes the general character of its surface to glacial action, though the periods of glaciation which influenced the region were separated by long periods of time. The section covered by the late Wisconsin ice sheet is characteristic of northern and eastern Wisconsin, and has a rather irregular topography, with many lakes and marshes. The region of old glaciation and the region which is largely residual have the more mature topography, with long, gentle slopes and but few lakes and marshes.

A total of 8 soil series, represented by 24 soil types, exclusive of the miscellaneous classifications, Peat and Rough stony land, are mapped in this survey. Two of the types are represented only by phases.

The Gloucester series consists of light-colored glaciated soils. The material is derived largely from crystalline rocks, and is noncalcareous. Eight types, ranging from sand to silt loam, are mapped. The silt loam and the phases of the fine sandy loam are extensive and important soils, although not yet extensively utilized.

The Spencer series includes the light-colored glaciated soils, with compact and strongly mottled subsoils. The soil material is derived largely from old glacial debris of crystalline origin, and the soils show varying degrees of acidity. Two types, the loam and silt loam, are mapped. The latter is the most extensive and one of the most important soils in the area.

The Whitman series consists of brownish-gray or black soils, high in organic matter, with lighter colored subsoils. The fine sand and silt loam are mapped. These soils occupy low, flat, poorly drained areas and depressions.

The Merrimac soils consist of material derived largely from crystalline-rock formations and deposited late in the glacial period as terraces or outwash plains. Three types are mapped. These are good agricultural soils.

The Plainfield series is similar to the Merrimac, except that the material has been derived more largely from sandstone formations. In Wisconsin no distinction is made between the light-textured Plainfield and Merrimac types, and the parent material of the three Plainfield soils mapped in the present survey is derived from crystalline rocks.

The Vesper series is characterized by light-colored soils high in silt and clay content, and underlain by sand or by bedrock, chiefly sandstone, at a depth of less than 3 feet. The surface usually is level, and the drainage is poor. The soil material is acid. The silt loam is the only type mapped.

The Boone series consists of light-colored material derived largely from sandstone. Three types are mapped in this area. Agriculturally they are relatively unimportant.

The Genesee series includes the brown or dark-brown soils of the first bottoms along streams. This land is subject to overflow. Two types are mapped, and each has a small total area.

Peat consists of decaying vegetable matter in varying stages of decomposition, with which there are incorporated small quantities of mineral matter. Much of the Peat can be drained and used to advantage for farming.

The areas mapped as Rough stony land consist mainly of rock outcrop, with intervening patches of shallow soil. They have no value for cultivated crops, and, although used to a very small extent for grazing, may generally be classed as nonagricultural.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Wisconsin.

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